



# **EDGEWOOD**

## **CHEMICAL BIOLOGICAL CENTER**

U.S. ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND

**ECBC-TR-611**

### **QUANTITATIVE UV ABSORBANCE SPECTRA OF CHEMICAL AGENTS AND SIMULANTS**

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**March 2008**

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DEPARTMENT OF THE ARMY  
U.S. Army Edgewood Chemical Biological Center  
Aberdeen Proving Ground, Maryland 21010-5424

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## CONTENTS

1.	INTRODUCTION .....	7
2.	BACKGROUND .....	7
3.	EXPERIMENTAL PROCEDURES .....	8
4.	RESULTS .....	8
5.	CONCLUSIONS.....	10
APPENDIXES		
	A - SAMPLE INFORMATION.....	11
	B - UV ABSORPTION SPECTRA .....	13
	C - MOLAR ABSORPTIVITY DATA ( $\text{L mole}^{-1} \text{ cm}^{-1}$ ) .....	29



## TABLES

1.	Molar Absorptivities at 248.25 and 262 nm .....	9
2.	Comparison to Literature Values: Absorption Cross Sections at 250 nm .....	10
3.	Comparison to Literature Values: Peak Absorption Cross Sections (cm <sup>2</sup> /molecule).....	10

# QUANTITATIVE UV ABSORBANCE SPECTRA OF CHEMICAL AGENTS AND SIMULANTS

## 1. INTRODUCTION

The quantitative ultraviolet (UV) absorption spectra of selected chemical agents and simulants have been measured for wavelengths in the near UV from 200 to 400 nm. Although these data are of interest in their own right, they are also necessary for predicting the sensitivity of UV Raman based detection systems. The absorption values at 248.25 and 262 nm are of particular interest as these correspond to excitation wavelengths used by UV Raman based surface contamination detectors currently under development. These wavelengths are produced by KrF excimer lasers and quadrupled Nd: YLF lasers, respectively.

## 2. BACKGROUND

To calculate the Raman scattering intensity of a given chemical, it is necessary to know how much of the incident and scattered radiation are absorbed by the sample. For transparent samples, the absorbance is negligible and no correction is required. Many organic chemicals, however, have absorbance bands below 300 nm, and this absorbance must be taken into account when calculating Raman scattering cross sections. The amount of radiation absorbed by a molecule is described by the Beer-Lambert Law shown in its various forms in eqs 1 through 3.

$$I = I_0 \times 10^{-\epsilon cl} \quad (1)$$

$$\text{Transmittance } T = \frac{I}{I_0} = 10^{-\epsilon cl} \quad (2)$$

$$\text{Absorbance } A = -\log T = \epsilon cl \quad (3)$$

where

$I_0$  = intensity of the incident radiation

$I$  = intensity of the transmitted radiation

$c$  = molar concentration of solute ( $M$ )

$l$  = path length of the cell ( $cm$ ), and

$\epsilon$  = molar extinction coefficient or molar absorptivity ( $L \times mole^{-1} \times cm^{-1}$ ).

Experimentally, absorbance is measured as a function of wavelength for either neat chemicals or solutions of known concentration. When the UV spectrum of a sample is measured in solution, the absorbance of the dilutant chemical must also be taken into account. The UV spectrum of the pure dilutant is obtained and subtracted from that of the solution. This correction is often automatically performed in the spectrometer software during data collection.

When diluting a chemical, a solvent with a low UV cutoff wavelength is chosen. The UV cutoff wavelength is the wavelength at which the absorbance is unity when measured against air in a 1-cm matching cell. Acetonitrile and water have UV cutoff wavelengths of 190 nm, which makes them suitable for UV absorption measurements above 190 nm. The path length  $l$  is determined by the width of the cuvette containing the sample. The molar absorptivity is then calculated at a specific wavelength using eq 3.

### 3. EXPERIMENTAL PROCEDURES

Absorbance data was collected for 29 chemical agents and simulants including the G agents, VX, and HD. The list of samples, along with information on their sources, is tabulated in Appendix A.

Solutions were prepared using standard chemistry techniques and methodology. Surety samples were handled in accordance with appropriate standing operating procedures. The concentrations were chosen so that the resulting absorbances at 248 and 262 nm were between approximately 0.5 and 2. Absorbances of greater than roughly 3 (a transmission of 0.1%) could not be measured because of low signal to noise. Conversely, concentrations that yielded low absorbances were imprecise because the small errors in blank (dilutant + cell) subtraction could dominate the measured absorbance. In the cases where multiple spectra are shown for the UV absorbance in Appendix B, the higher concentration was used to calculate molar absorptivities in Table 1 and Appendix C.

Except for methylphosphonic acid (MPA), all samples were used either neat or diluted with acetonitrile. The MPA, a solid, was dissolved in distilled and deionized water. The solutions were placed in rectangular Spectrosil Quartz fluorometer cells (Starna Cells, Inc). One centimeter pathlength cells were used except for GB where measurements were made in a 0.1 cm pathlength cell. The cells were filled at least 2/3 full.

Data was collected using a Varian Cary 50 UV-VIS spectrometer using a xenon flash lamp light source. A beam splitter is incorporated to allow simultaneous reference beam correction. Several variables could be adjusted within the software. All data collection occurred at a scan rate of 300 nm/min over the wavelength range of 200-400 nm with a measurement interval size of 0.5 nm. Spectra of dilutant chemicals were obtained at the start of each day prior to data collection (see examples in Appendix B). The appropriate spectrum was automatically subtracted from that of the solution during data collection.

### 4. RESULTS

For each sample, absorbance data between 200 and 400 nm were recorded as a function of wavelength and used to calculate molar absorptivity values, as described above. These values, as a function of wavelength, appear in Appendixes B (spectra) and C (data tables).



As mentioned above, the molar absorptivity values at 248.25 and 262 nm are of special interest due to their importance in calculating UV Raman scattering cross-sections for UV Raman based surface detectors in development. These values are listed in Table 1.

Table 1. Molar Absorptivities at 248.25 and 262 nm

Chemical	Abbreviation	$\epsilon$ (L mol <sup>-1</sup> cm <sup>-1</sup> )	
		248.25 nm	262 nm
2-Chloroethyl ethyl sulfide	CEES	1.6E+01	2.2E+00
3-quinuclidinyl benzilate	BZ	2.2E+02	1.7E+02
Arsenic trichloride	AsCl <sub>3</sub>	2.3E+02	8.9E+01
Chloroacetophenone	CN	9.6E+03	2.1E+03
Chloropicrin (trichloronitromethane)	PS	2.1E+01	4.1E+01
Cyclosarin	GF	5.0E+00	4.3E+00
Diethyl malonate	DEM	1.5E+00	3.1E-01
Ethyl methylphosphonic acid	EMPA	1.1E-01	5.2E-02
Ethylchloroarsine	ED	9.0E+02	4.4E+02
Isopropyl methylphosphonic acid	IMPA	1.9E-01	1.4E-01
Lewisite	L	3.6E+03	1.7E+03
Methyl salicylate	MES	1.3E+03	1.8E+02
Methyldichloroarsine	MD	9.8E+02	2.8E+02
Methylphosphonic acid	MPA	1.6E+00	1.6E+00
N-mustard	HN-1	4.0E+01	9.2E+00
N-mustard	HN-3	2.4E+01	4.8E+00
O-Diisopropyl methylphosphonate	DIMP	1.5E-01	7.3E-02
O-Dimethyl methylphosphonate	DMMP	1.2E-01	7.1E-02
O-ethyl-S-(2-isopropylaminoethyl)methyl phosphonothioate	VX	7.6E+02	2.4E+02
O-Triethylphosphate	TEPO	4.9E-02	4.0E-02
Phenyldichloroarsine	PD	2.5E+03	1.5E+03
Phosgene Oxime	CX	2.8E+00	2.6E-01
Pinacolyl methylphosphonic acid	PMPA	1.2E+00	7.6E-01
Sarin	GB	7.4E-01	5.6E-01
Soman	GD	1.9E+00	8.1E-01
Sulfur Mustard	HD	1.8E+01	1.6E+00
Tabun	GA	1.8E+00	9.5E-01
Thiodiglycol	TDG	4.8E+00	8.2E-01
T-mustard	T	1.9E+01	6.2E+00



As can be seen, the absorptivity of the samples varied widely. For the nerve agents, VX is much more highly absorbing at 248 nm than any of the G agents, which are relatively weak absorbers in the near UV. The molar absorptivity of the mustard agent and lewisite are also more than an order of magnitude larger than the G agents. In Tables 2 and 3, we compare our results to those published in the open literature by Rewick et al.\* Our data has been converted to units of square centimeters/molecule to conform to the data in the reference.\* The conversion from molar absorptivity in  $\text{L}\cdot\text{mole}^{-1}\cdot\text{cm}^{-1}$  to cross section is accomplished by multiplying by  $1000/N_0$ , where  $N_0$  is Avagadro's number. Except for GA, the values agree reasonably well. Our results for GA are in line with the other G agents, while the Rewick's absorption cross section is two orders of magnitude larger than any of the other G agents. The reason for this discrepancy is unknown, but may be attributable to a highly absorbing impurity or degradation product in Rewick's sample.

Table 2. Comparison to Literature Values: Absorption Cross Sections at 250 nm ( $\text{cm}^2/\text{molecule}$ )

	Rewick <sup>1</sup>	This Study	Ratio
GA	9.0E-19	2.6E-21	342
GB	1.2E-21	1.2E-21	1.0
GD	4.0E-21	2.8E-21	1.5
VX	9.0E-19	1.1E-18	0.8
HD	2.8E-20	2.2E-20	1.4
L	1.1E-17	5.6E-18	2.0
CEES	3.1E-20	2.0E-20	1.6
DMMP	2.1E-22	1.6E-22	1.2

Table 3. Comparison to Literature Values: Peak Absorption Cross Sections ( $\text{cm}^2/\text{molecule}$ )

	Rewick <sup>1</sup>	This Study	Ratio
HD (205 nm)	6.9E-18	2.8E-18	2.5
L (215 nm)	3.1E-17	1.7E-17	1.8

## 5. CONCLUSIONS

The molar absorptivities were calculated for 29 chemical agents and simulants as a function of wavelength. The data collected during this project also alerts researchers to areas of possible challenge for detectors based on ultraviolet Raman scattering.

\*Rewick, Robert T.; Schumacher, Mary L.; Haynes, Daniel L. The UV Absorption Spectra of Chemical Agents and Simulants. *Appl. Spectrosc.* **1986**, 40 (2), pp 152-156.

# APPENDIX A

## SAMPLE INFORMATION

A list of sample chemicals and their sources appears below. In the case of agents (in bold type) the Chemical Agent Standard Reference Material (CASARM) number is listed. All chemicals were laboratory grade.

Abbv.	Chemical Name	CAS #	LOT #
ACN	Acetonitrile	75-05-8	J. T. BAKER #A03810
AsCl <sub>3</sub>	Arsenic Trichloride	7784-34-1	STREM CHEMICALS #B5872121
<b>BZ</b>	<b>3-quinuclidinyl benzilate</b>	<b>6581-06-2</b>	<b>BZ-U-1057</b>
CEES	2-Chloroethyl ethyl sulfide	693-07-2	ALDRICH #09226CY HY
<b>CN</b>	<b>Chloroacetophenone</b>	<b>532-27-4</b>	<b>ALDRICH #08222BA</b>
<b>CX</b>	<b>Phosgene Oxime</b>	<b>1794-86-1</b>	
DEM	Diethyl malonate	105-53-3	FLUKA #39006/1 892
DIMP	O-Diisopropyl methylphosphonate	1445-75-6	JOHNSON MATTHEY #12831
DMMP	O-Dimethyl methylphosphonate	756-79-6	ALDRICH #021497 BD
<b>ED</b>	<b>Ethylldichloroarsine</b>	<b>598-14-1</b>	<b>MW-03-0077-115</b>
EMP.A	Ethyl methylphosphonic acid	1832-53-7	ALDRICH #03517MY CR
<b>GA</b>	<b>Tabun, Ethyl N,N-dimethylphosphor-amidocyanidate</b>	<b>77-81-6</b>	<b>93-0034-100.2 VIAL#50</b>
<b>GB</b>	<b>Sarin, 2-(fluoro-methyl-phosphoryl)oxypropane</b>	<b>107-44-8</b>	<b>GB-U-9146-CTF VIAL #91/81</b>
<b>GD</b>	<b>Soman, 3-(fluoro-methyl-phosphoryl)oxy-2,2-dimethyl-butane</b>	<b>96-64-0</b>	<b>GD-U-2323-CTF-N</b>
<b>GF</b>	<b>Cyclosarin, (fluoro-methyl-phosphoryl)oxycyclohexane</b>	<b>329-99-7</b>	<b>GF-S-6092-CTF-N-2</b>
<b>HD</b>	<b>Sulfur Mustard, Bis(2-chloroethyl) sulfide</b>	<b>505-60-2</b>	<b>HD-U-9045-CTF-N</b>
<b>HN-1</b>	<b>Nitrogen Mustard, 2-chloro-N-(2-chloroethyl)-N-ethyl-ethanamine</b>	<b>538-07-8</b>	<b>HN-9210</b>
<b>HN-3</b>	<b>Nitrogen Mustard, 2-chloro-N,N-bis(2-chloroethyl)ethanamine</b>	<b>555-77-1</b>	<b>HN3-92-CTF-N #130</b>
IMPA	Isopropyl methylphosphonic acid	1832-54-8	ECBC #14049
<b>L</b>	<b>Lewisite, 2-chloroethenyldichloroarsine</b>	<b>541-25-3</b>	<b>L-U-6242-CTF-N</b>

Abbv	Chemical Name	CAS #	LOT #
MD	Methyldichloroarsine	593-89-5	MW-03-0077-114
MES	Methyl salicylate	119-36-8	ALDRICH #12115DY PZ
MPA	Methylphosphonic acid	993-13-5	FLUKA #299131 690
PD	Phenyldichloroarsine	696-28-6	MW-03-0077-108
PMPA	Pinacolyl methylphosphonic acid	616-52-4	ALDRICH #03711LY CR
PS	Chloropicrin	76-06-2	ALDRICH #04222TB
T	T Mustard, bis[2(2-chloroethylthio)ethyl] ether	693-07-2	99-003-149-4
TDG	Thiodiglycol	111-48-8	FLUKA #37419-491
TEPO	O-Triethylphosphate	78-40-0	ECBC 850059P36-CUT3
VX	O-ethyl S-(2-diisopropylaminoethyl) methylphosphonothiolate	50782-69-9	VX-U-4308-CTF-N
Water	18 mΩ deionized water	7732-18-5	



APPENDIX B

UV ABSORPTION SPECTRA

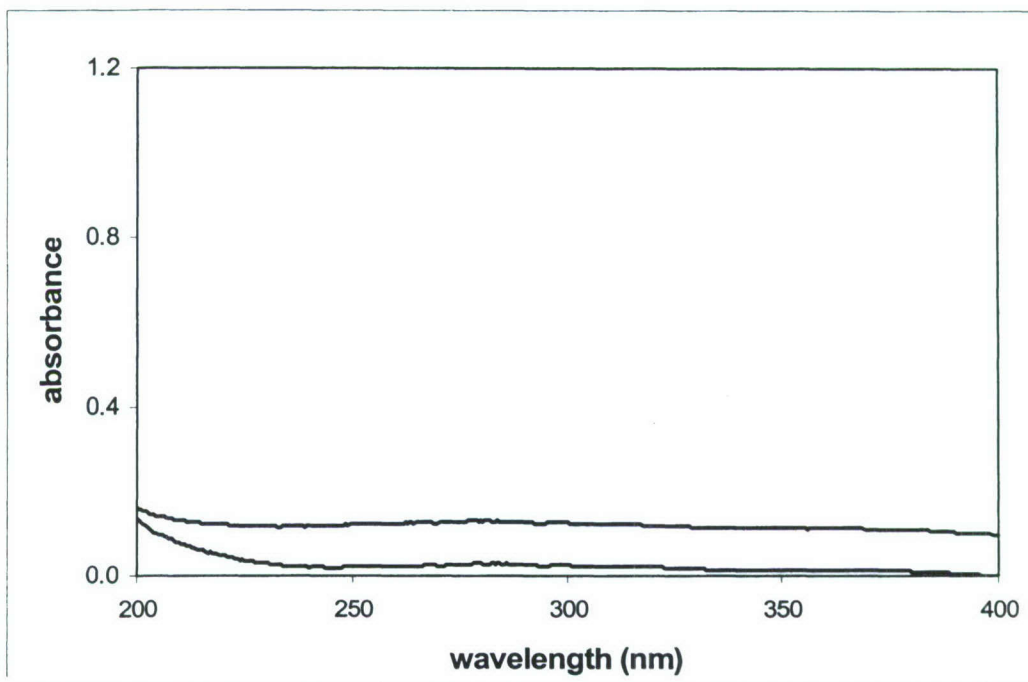


Figure B-1. Absorption Spectrum of Neat Water (upper trace) and Acetonitrile (lower trace)

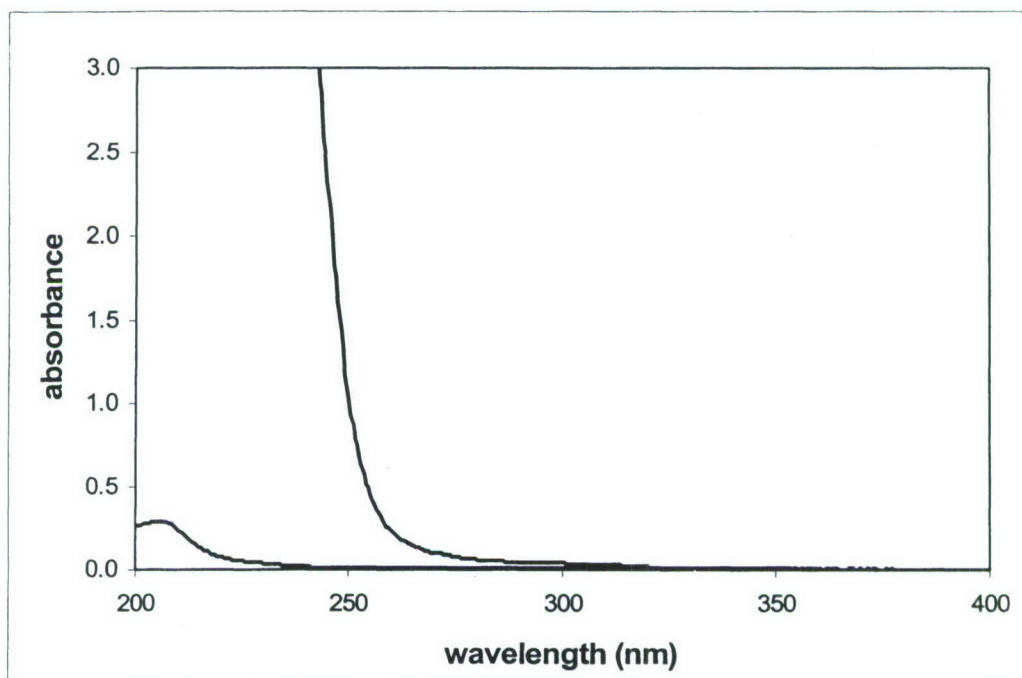


Figure B-2. Absorption Spectrum of  $8.59 \times 10^{-2}$  M (upper trace) and  $1.07 \times 10^{-5}$  M (lower trace) CEES



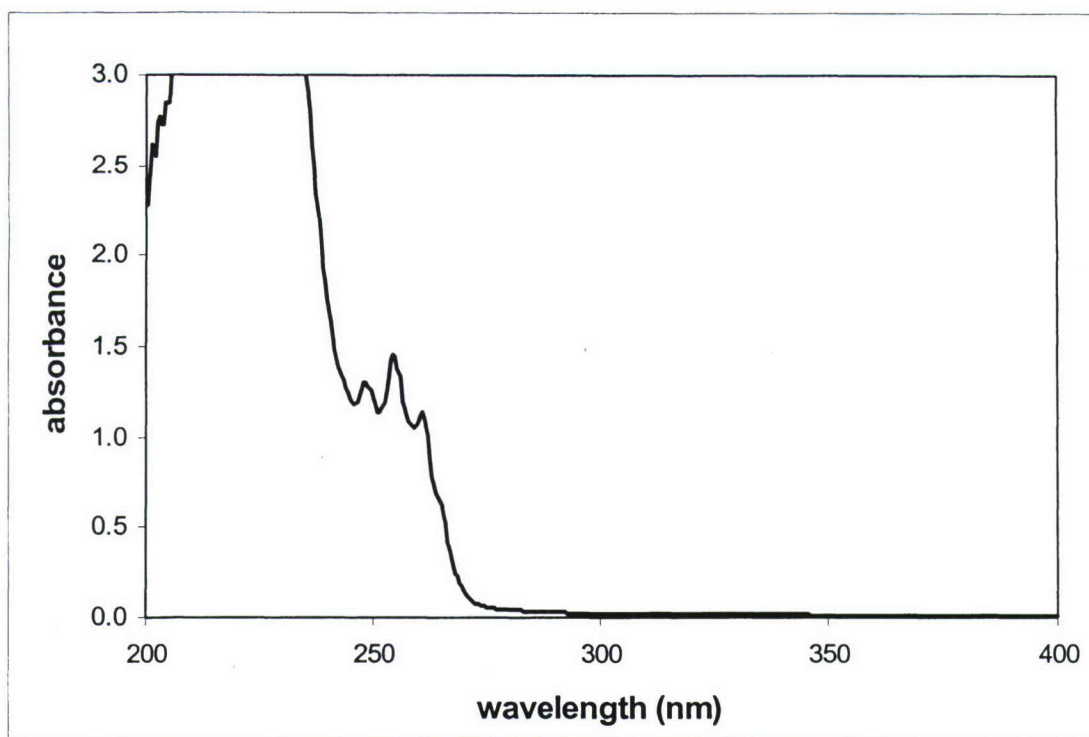


Figure B-3. Absorption Spectrum of  $5.88 \times 10^{-3}$  M BZ

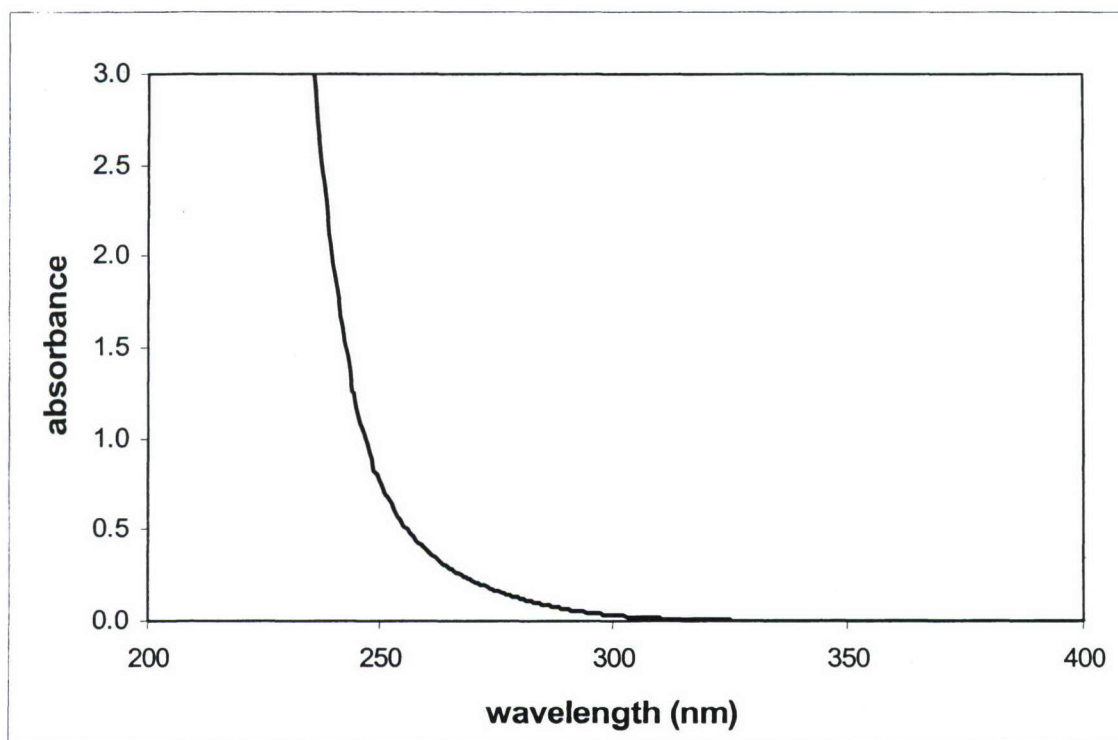


Figure B-4. Absorption Spectrum of  $3.95 \times 10^{-3}$  M AsCl<sub>3</sub>

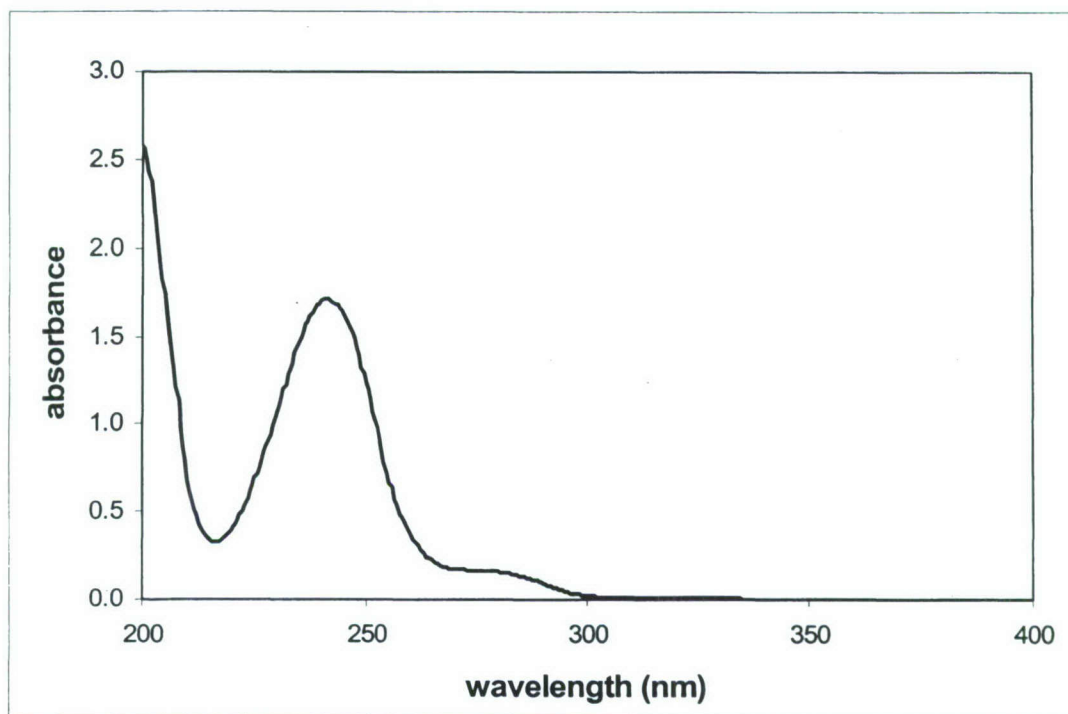


Figure B-5. Absorption Spectrum of  $1.48 \times 10^{-4}$  M CN

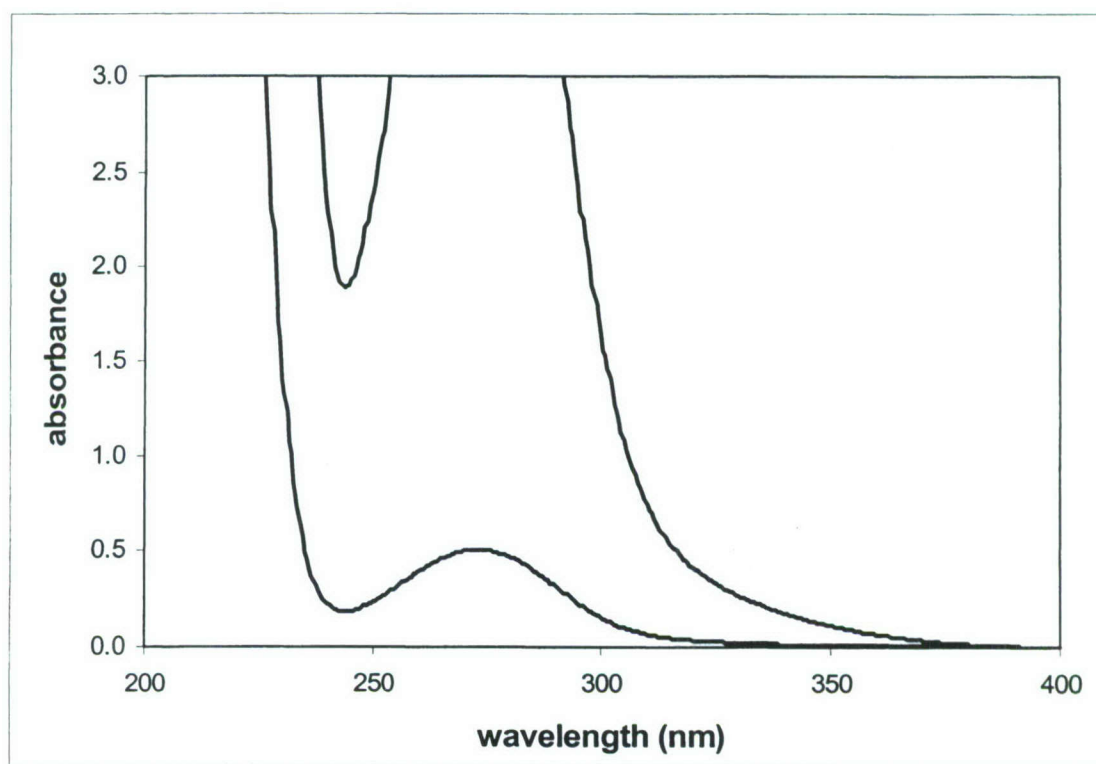


Figure B-6. Absorption Spectrum of  $1.01 \times 10^{-1}$  M (upper trace) and  $1.01 \times 10^{-2}$  M (lower trace) PS

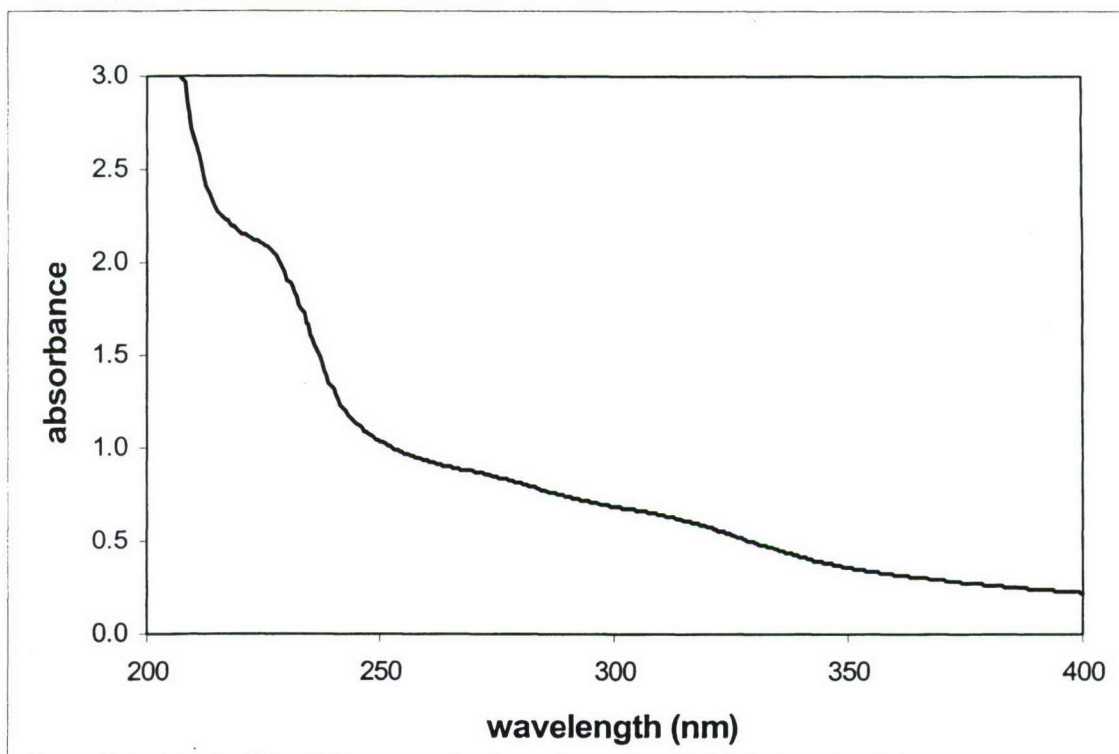


Figure B-7. Absorption Spectrum of  $2.13 \times 10^{-1}$  M GF

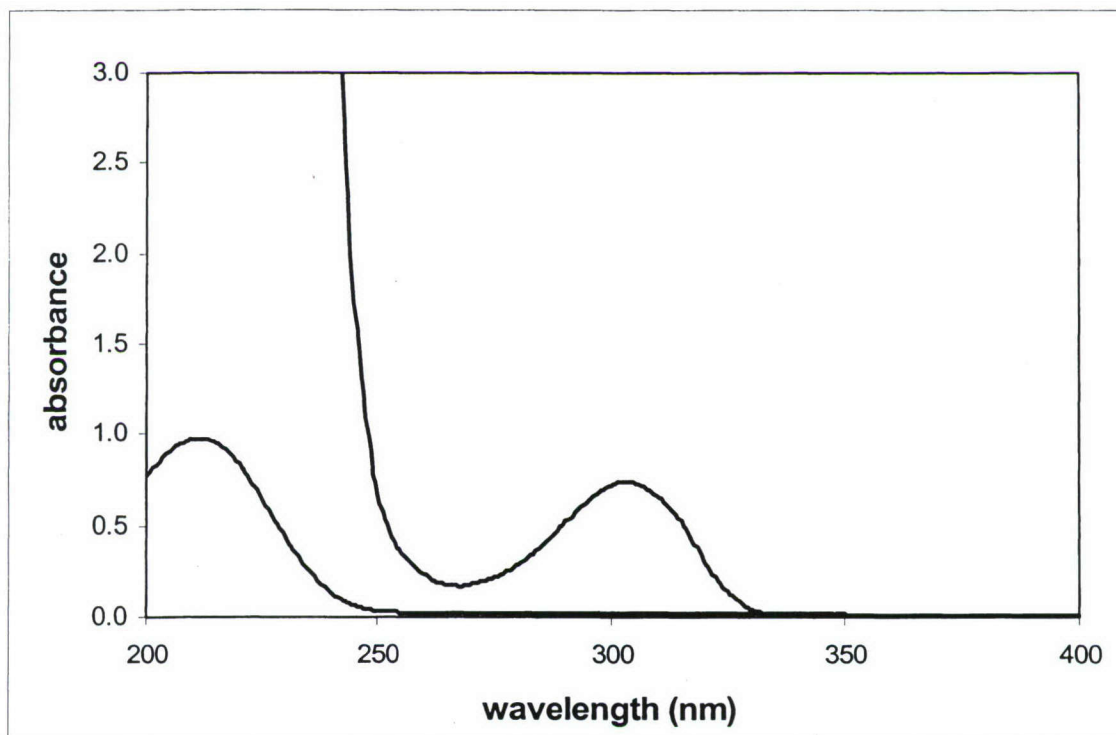


Figure B-8. Absorption Spectrum of  $6.50 \times 10^{-1}$  M (upper trace) and  $6.52 \times 10^{-3}$  M (lower trace) DEM

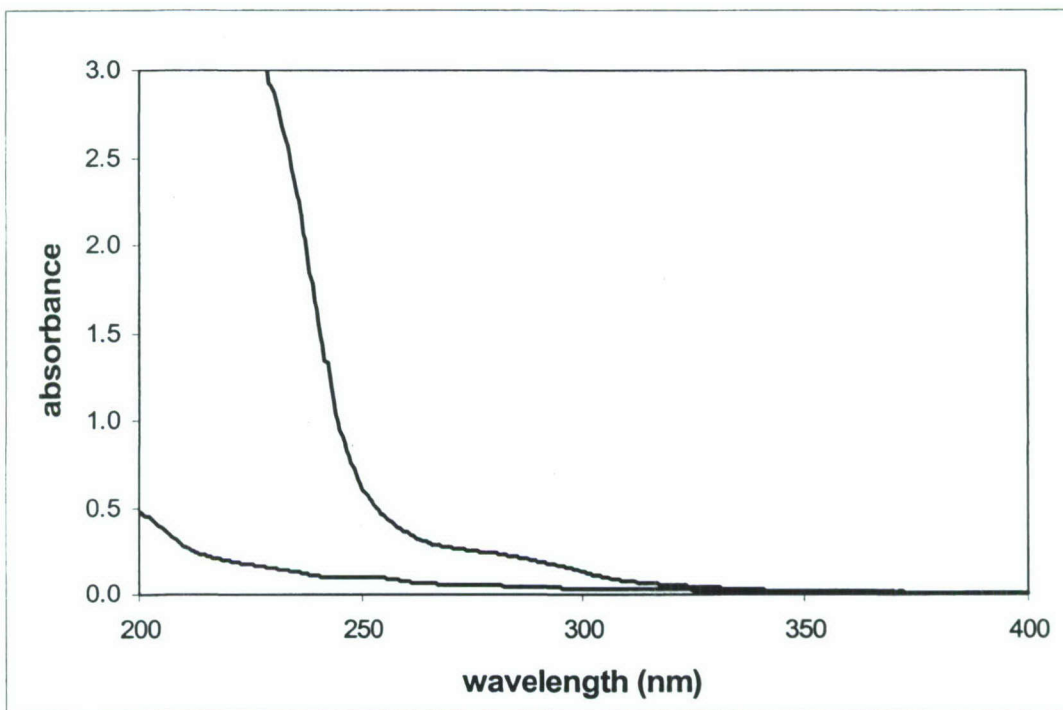


Figure B-9. Absorption Spectrum of 6.30 M (upper trace) and  $1.16 \times 10^{-2}$  M (lower trace) EMPA

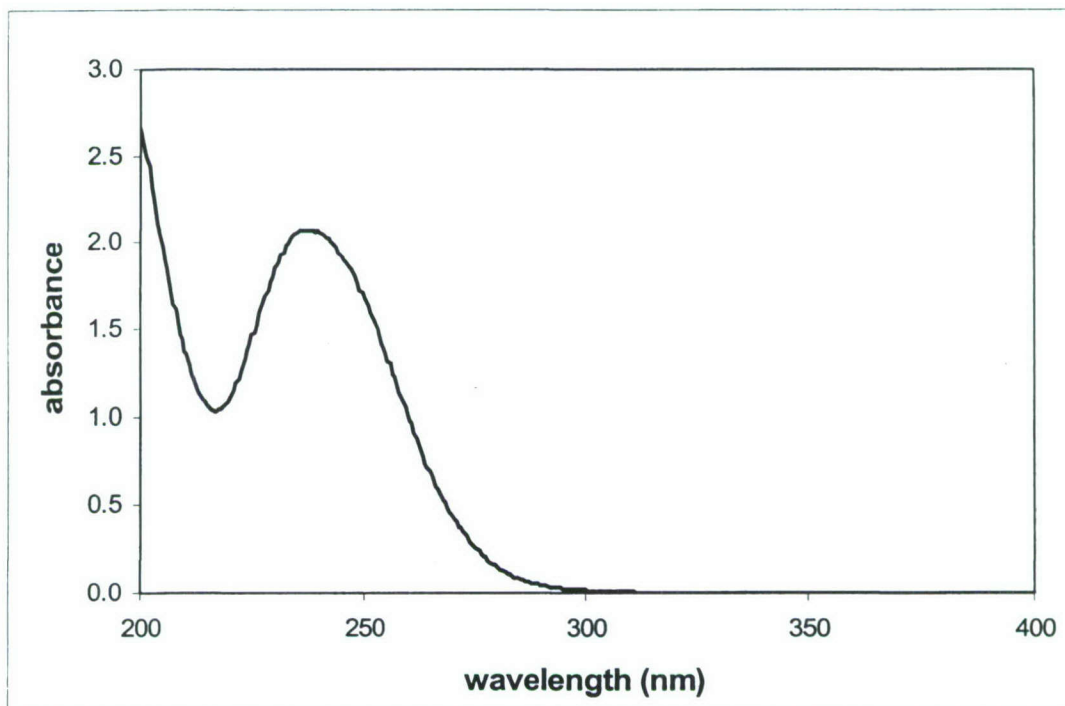


Figure B-10. Absorption Spectrum of  $1.99 \times 10^{-3}$  M ED



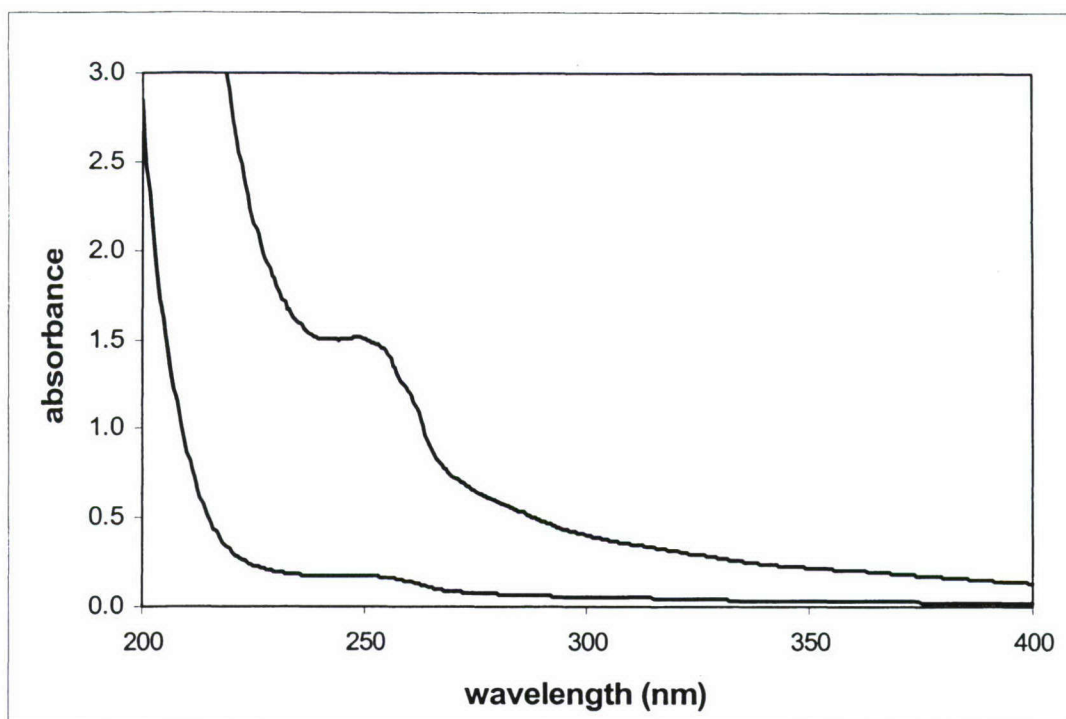


Figure B-11. Absorption Spectrum of Neat (upper trace) and  $7.94 \times 10^{-2}$  M (lower trace) IMPA

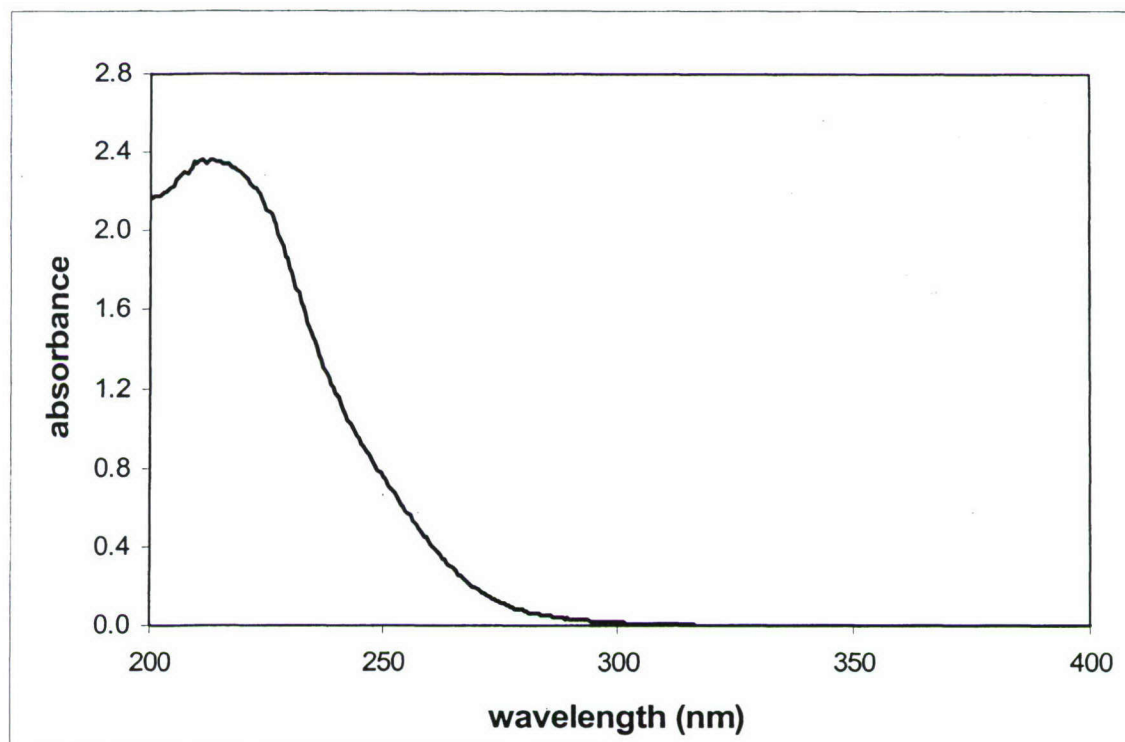


Figure B-12. Absorption Spectrum of  $2.27 \times 10^{-4}$  M L

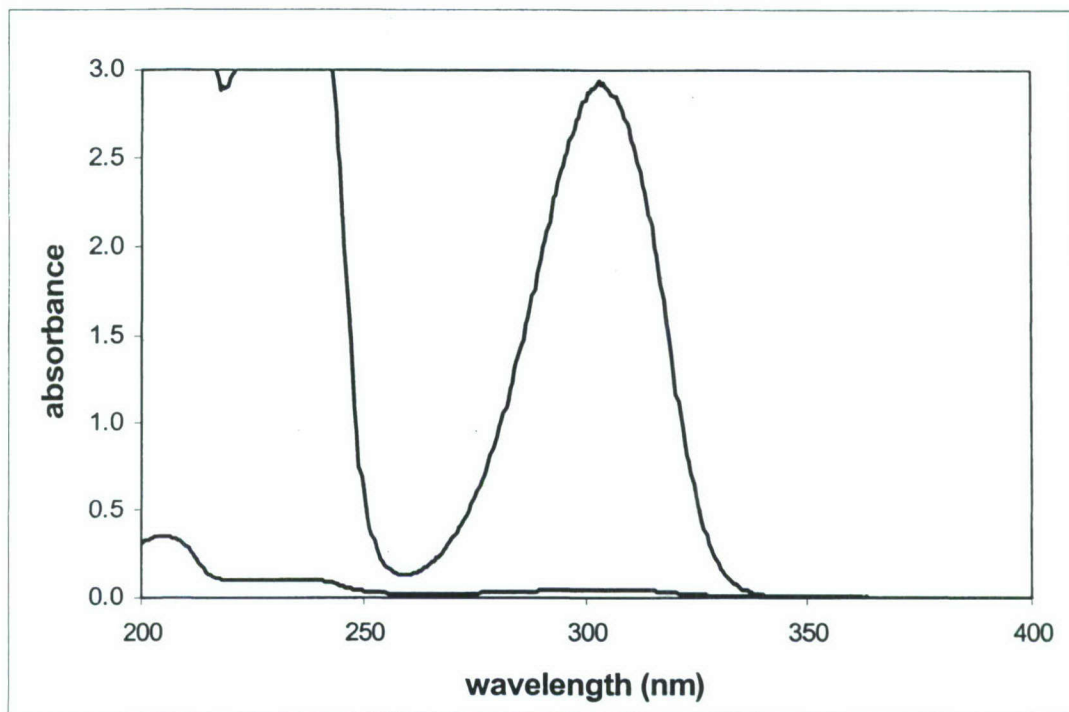


Figure B-13. Absorption Spectrum of  $7.72 \times 10^{-4}$  M (upper trace) and  $7.72 \times 10^{-6}$  M (lower trace) MES

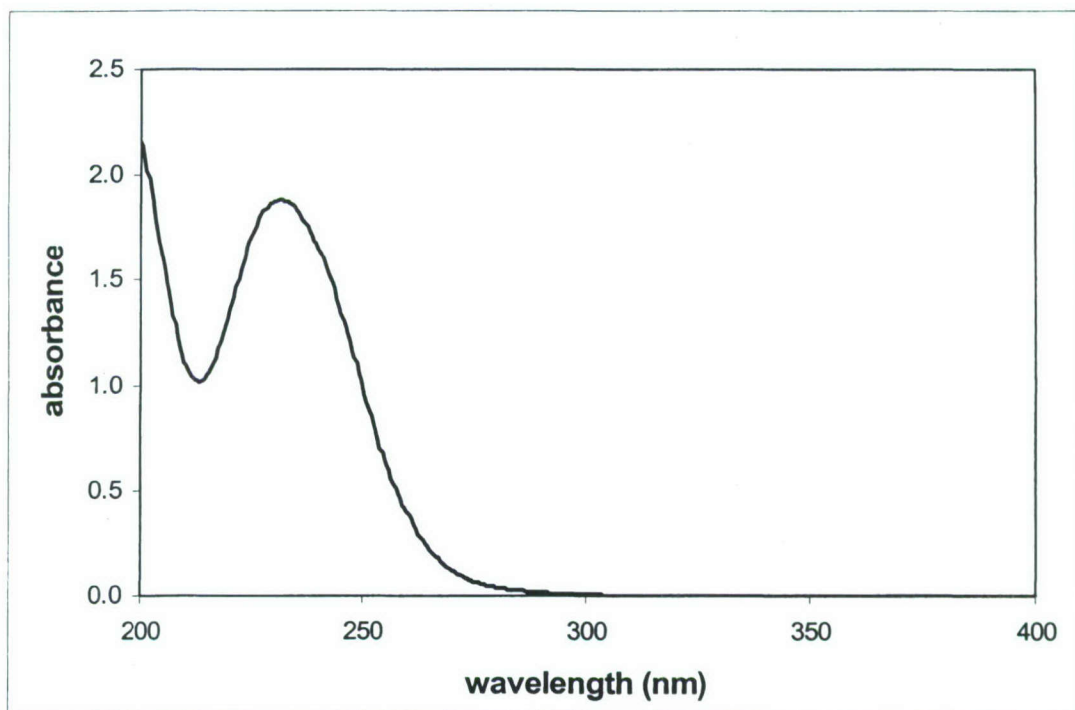


Figure B-14. Absorption Spectrum of  $1.14 \times 10^{-3}$  M MD

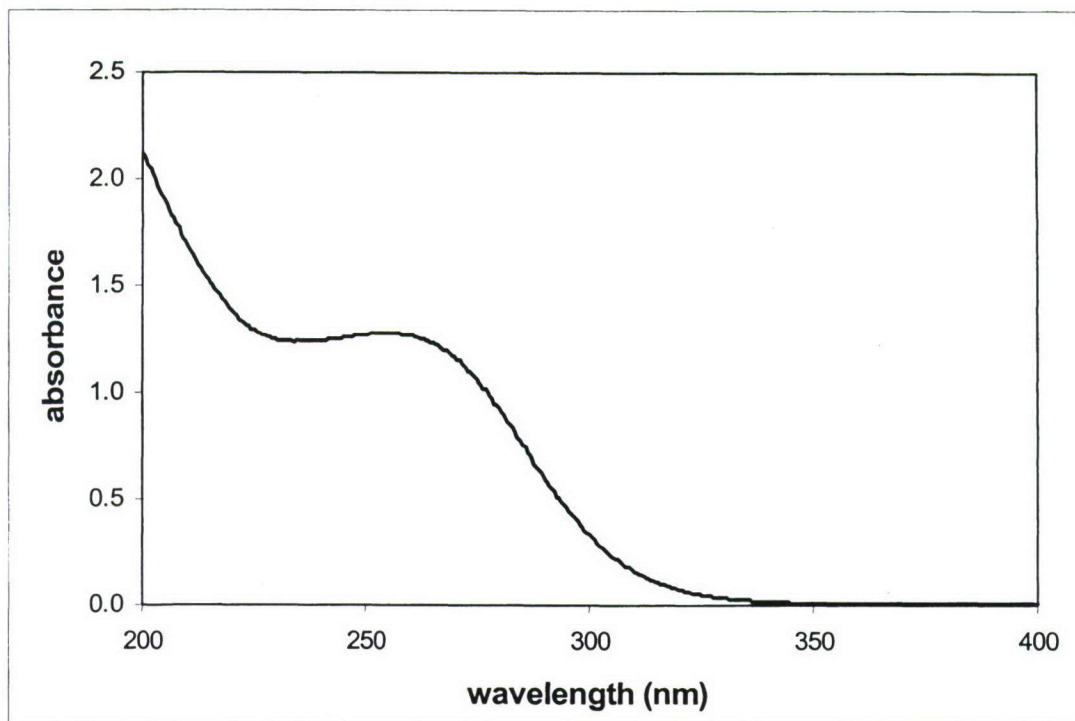


Figure B-15. Absorption Spectrum of  $7.87 \times 10^{-1}$  M MPA

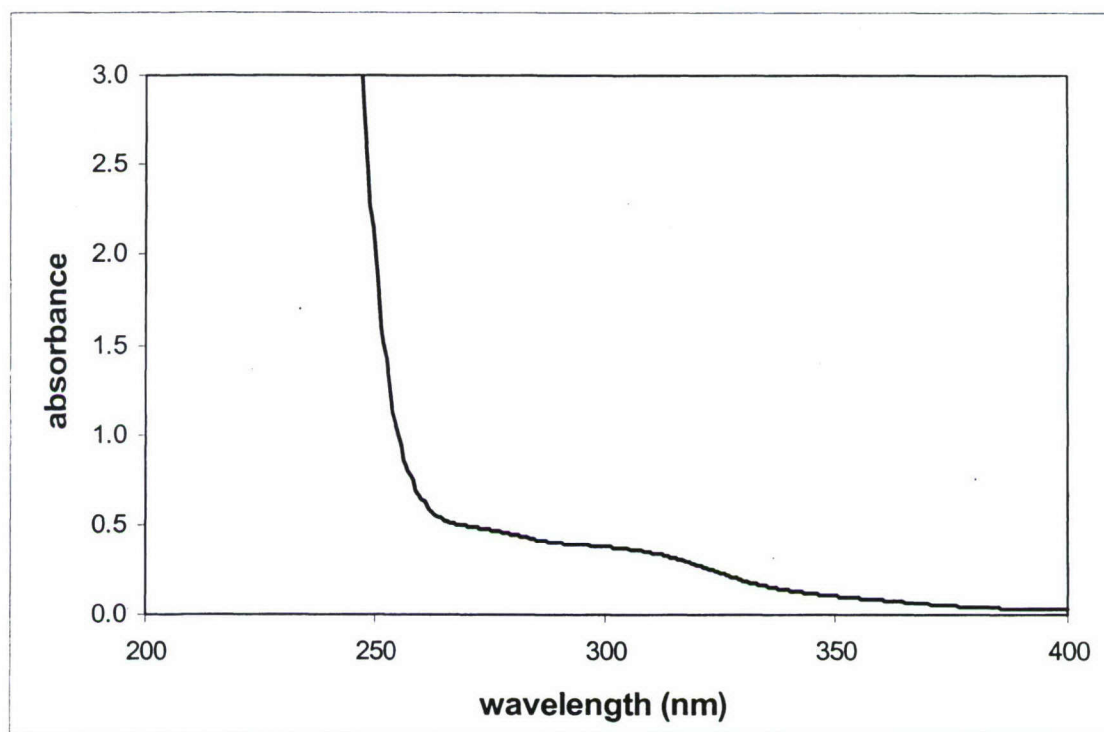


Figure B-16. Absorption Spectrum of  $6.39 \times 10^{-2}$  M HN-1

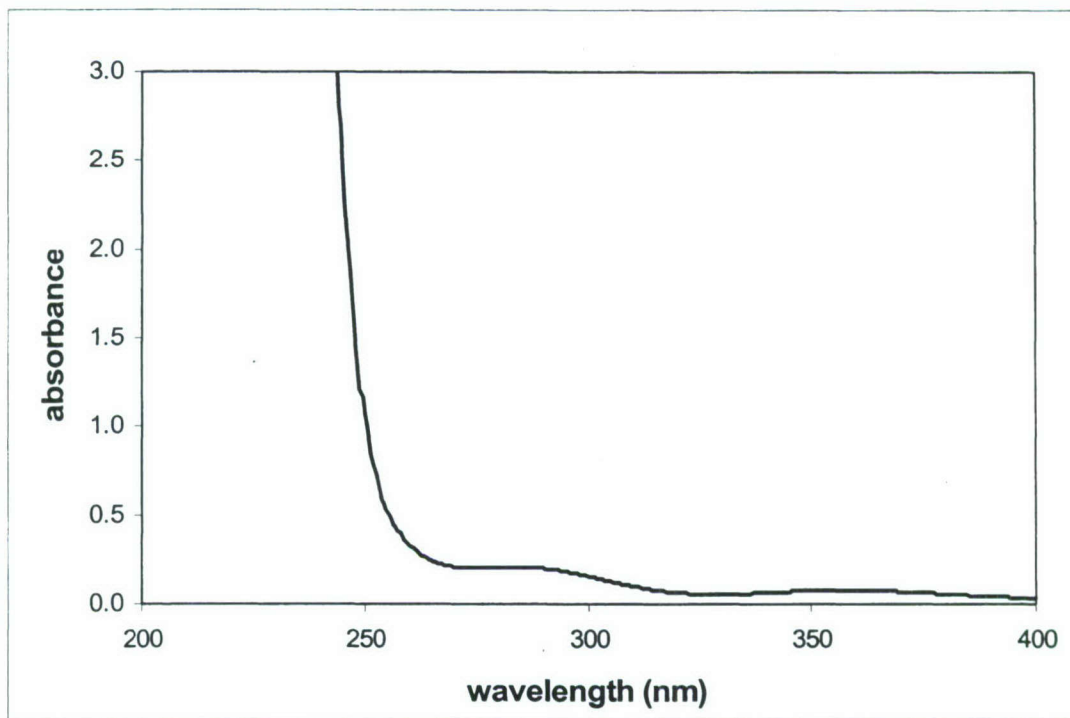


Figure B-17. Absorption Spectrum of  $5.98 \times 10^{-2}$  M HN-3

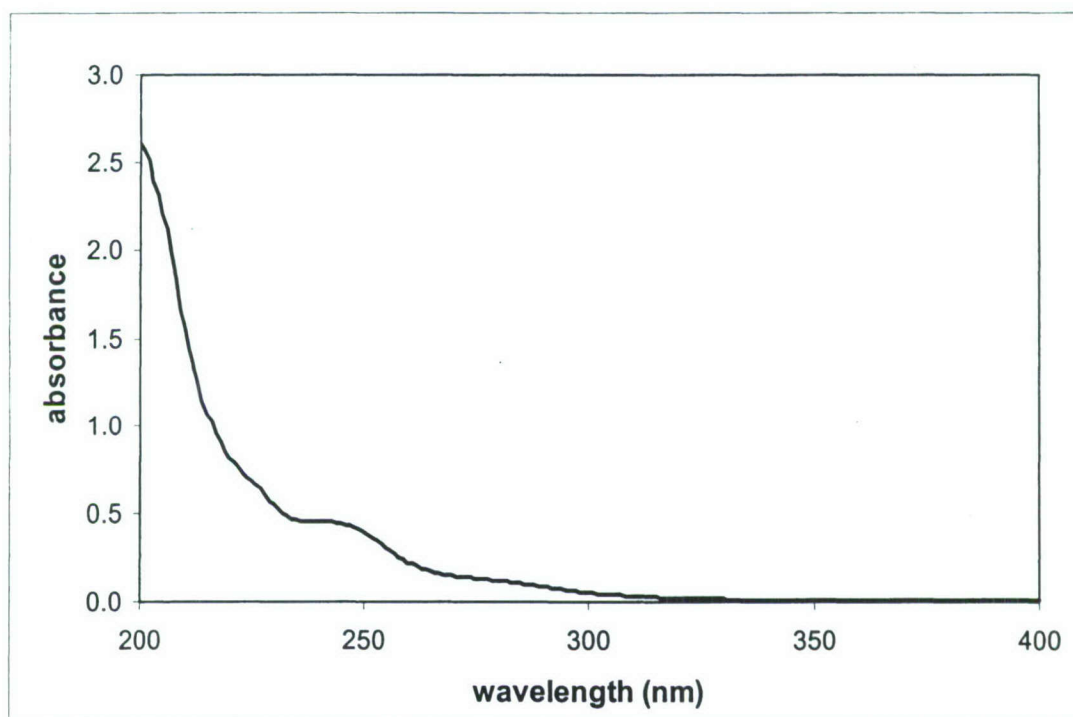


Figure B-18. Absorption Spectrum of Neat DIMP

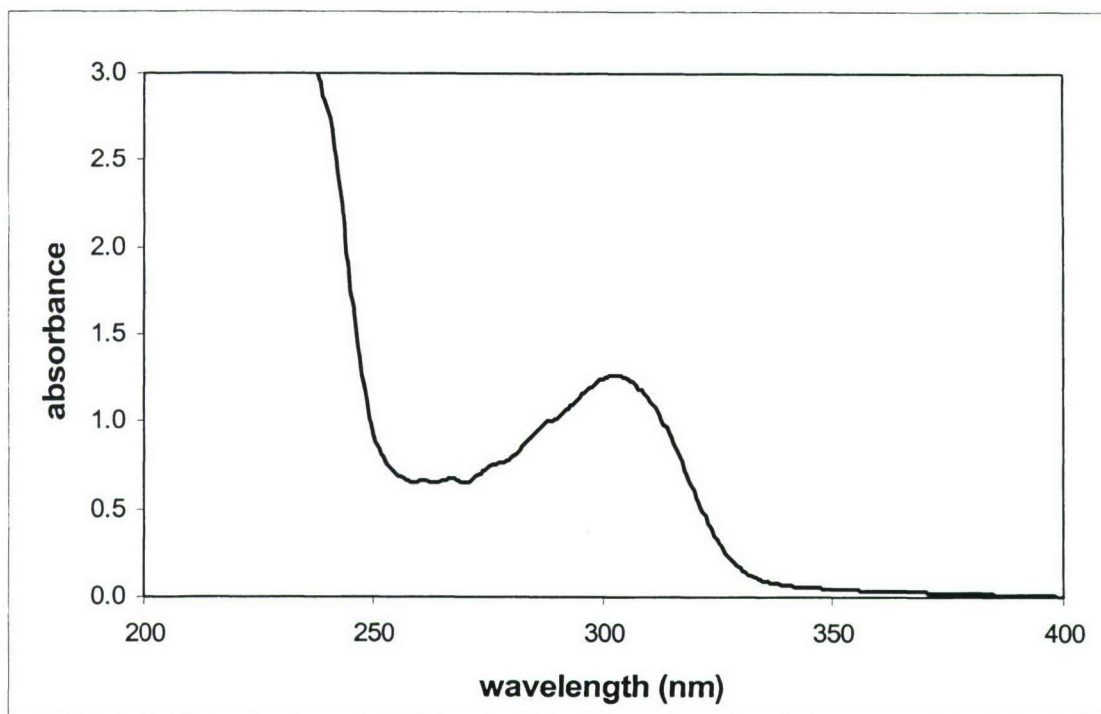


Figure B-19. Absorption Spectrum of Neat DMMP

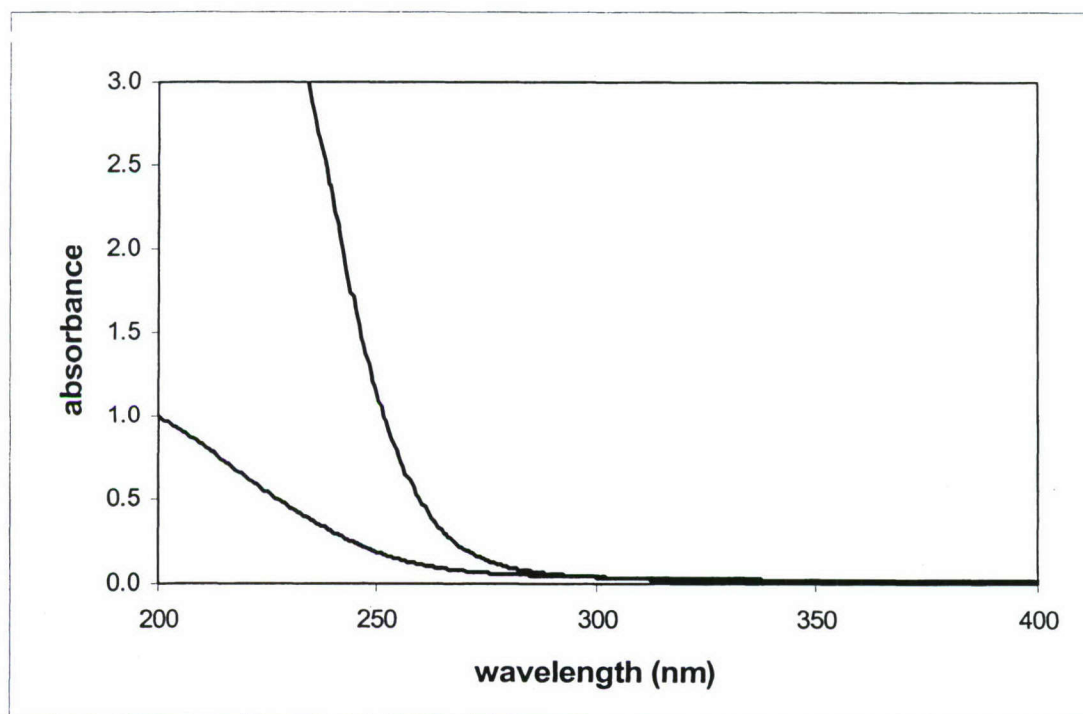


Figure B-20. Absorption Spectrum of  $1.69 \times 10^{-3}$  M (upper trace) and  $1.13 \times 10^{-4}$  M (lower trace) VX

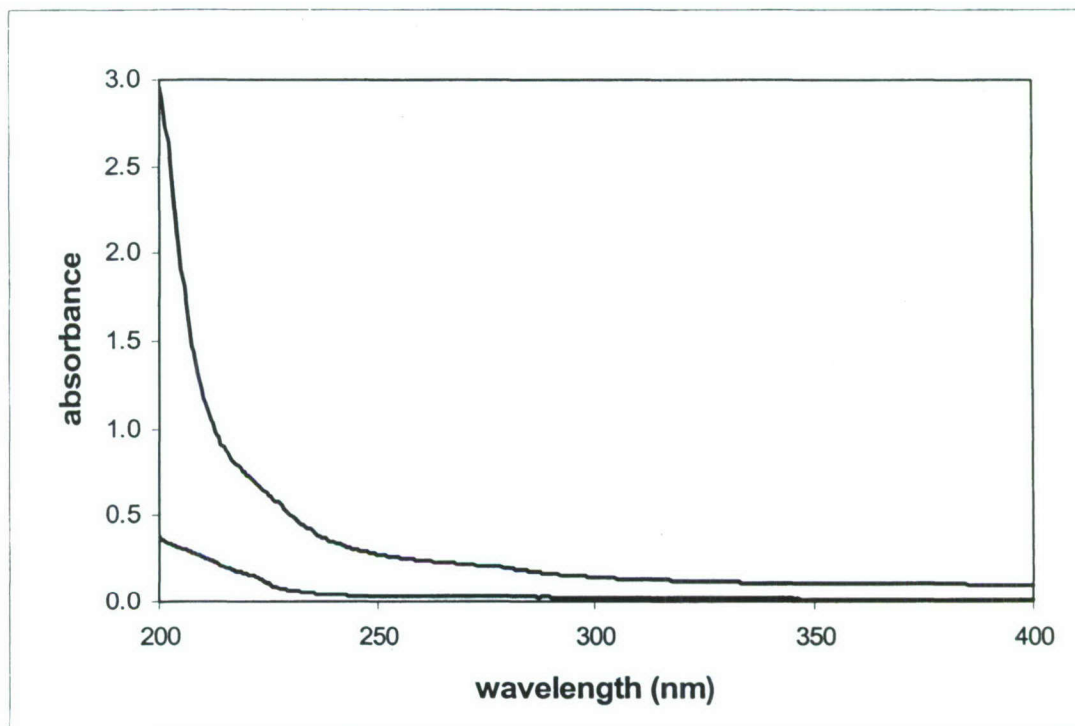


Figure B-21. Absorption Spectrum of Neat (upper trace) and  $5.82 \times 10^{-2}$  M (lower trace) TEPO

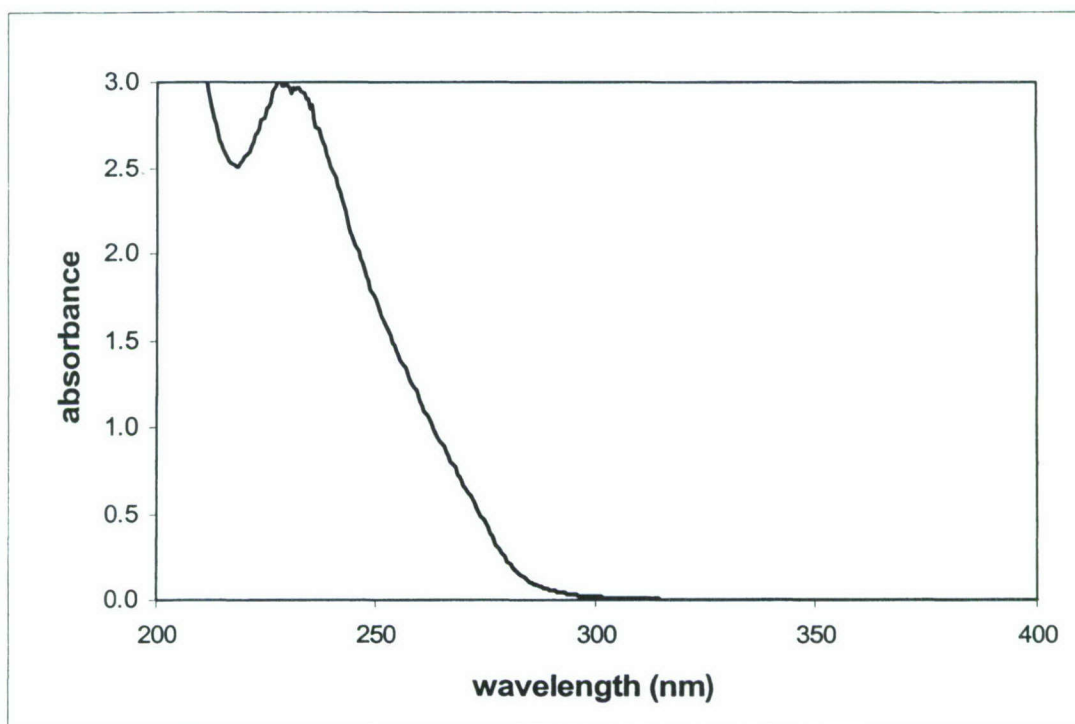


Figure B-22. Absorption Spectrum of  $7.38 \times 10^{-4}$  M PD

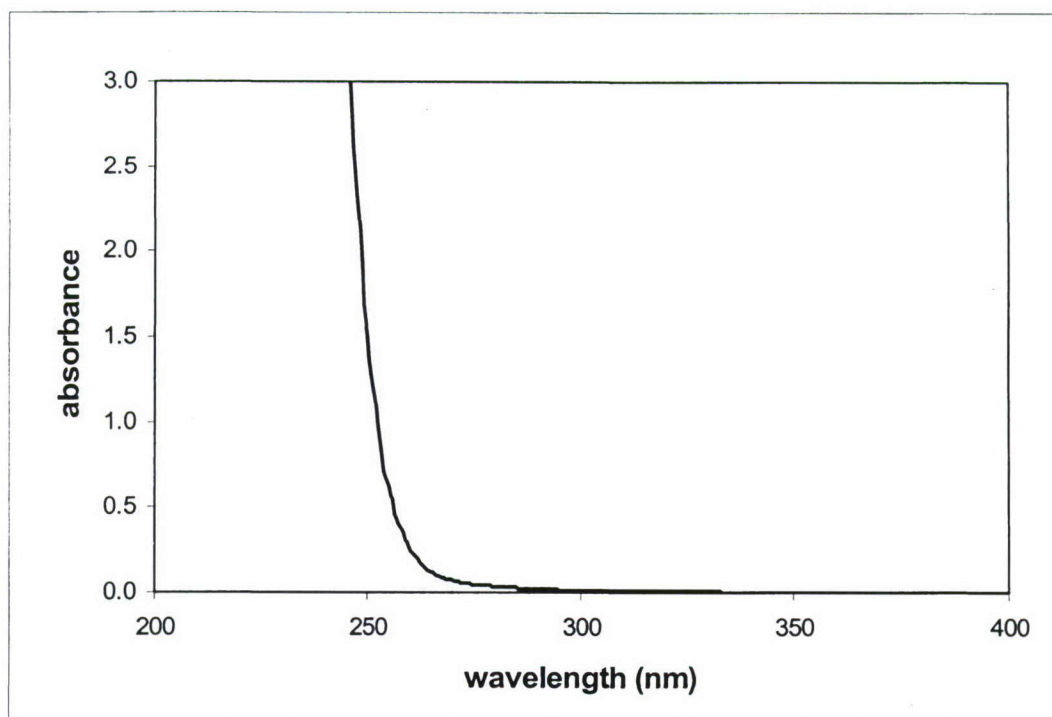


Figure B-23. Absorption Spectrum of  $7.42 \times 10^{-1}$  M CX

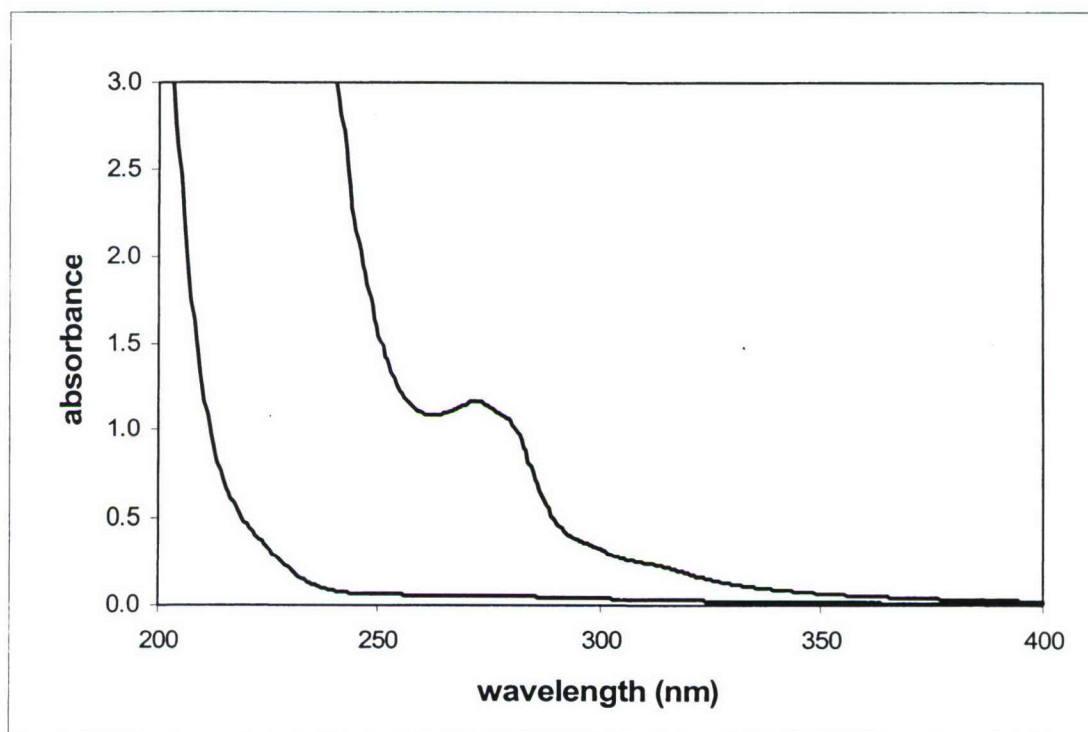


Figure B-24. Absorption Spectrum of 1.43 M (upper trace) and  $5.67 \times 10^{-2}$  M (lower trace) PMPA



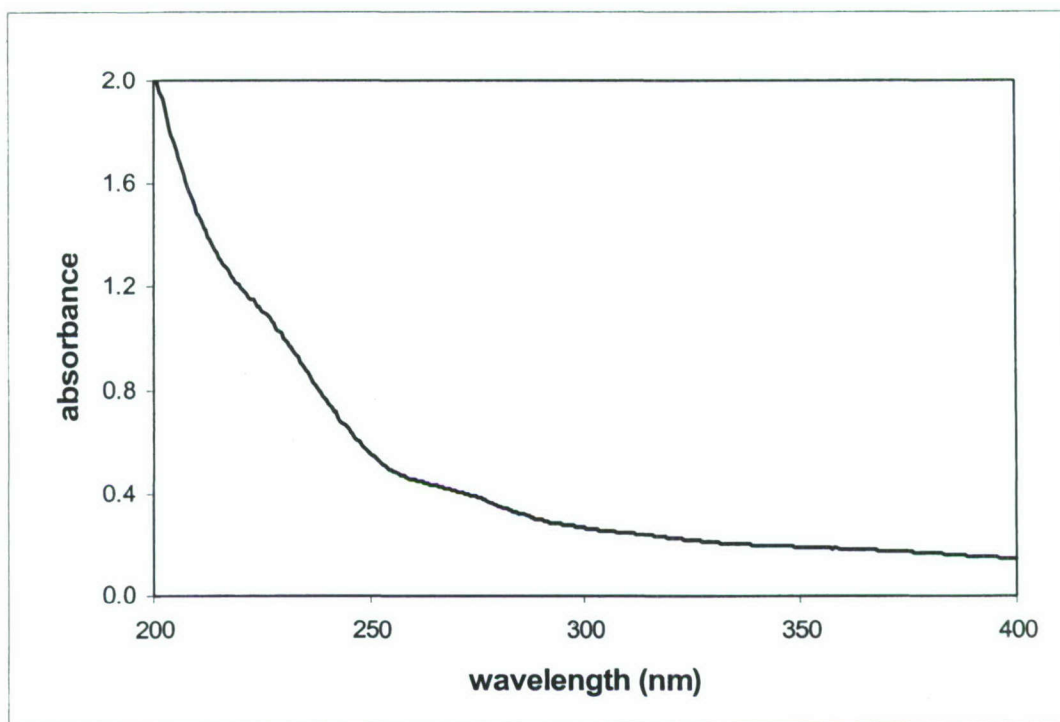


Figure B-25. Absorption Spectrum of Neat GB

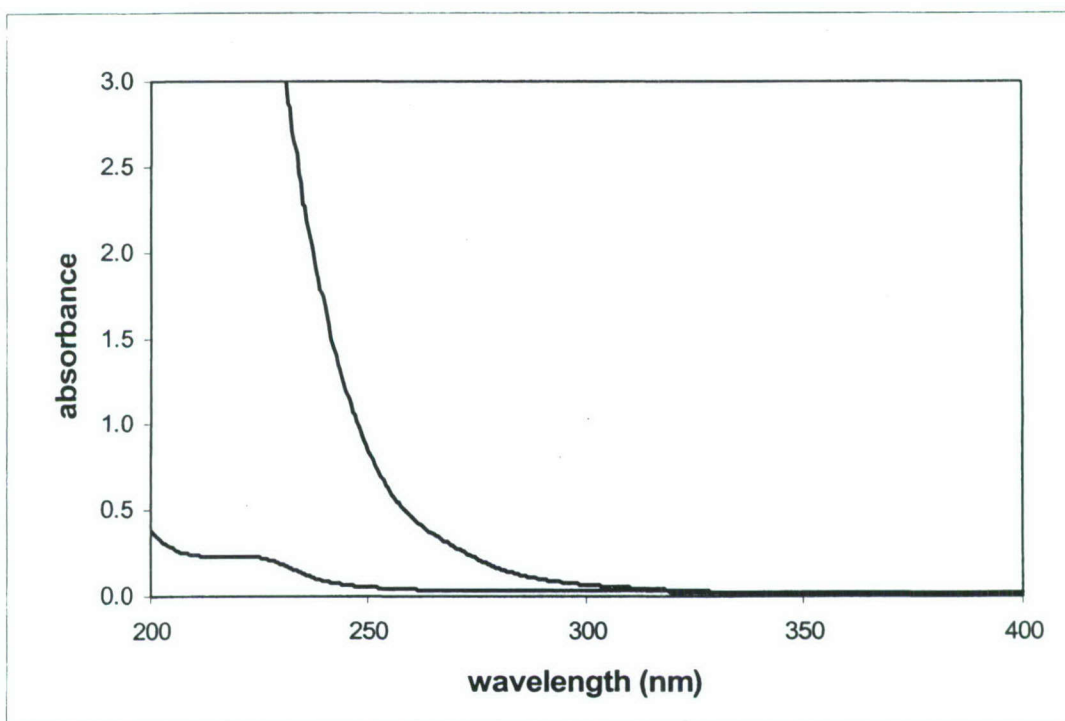


Figure B-26. Absorption Spectrum of  $5.10 \times 10^{-1}$  M (upper trace) and  $2.74 \times 10^{-2}$  M (lower trace) GD

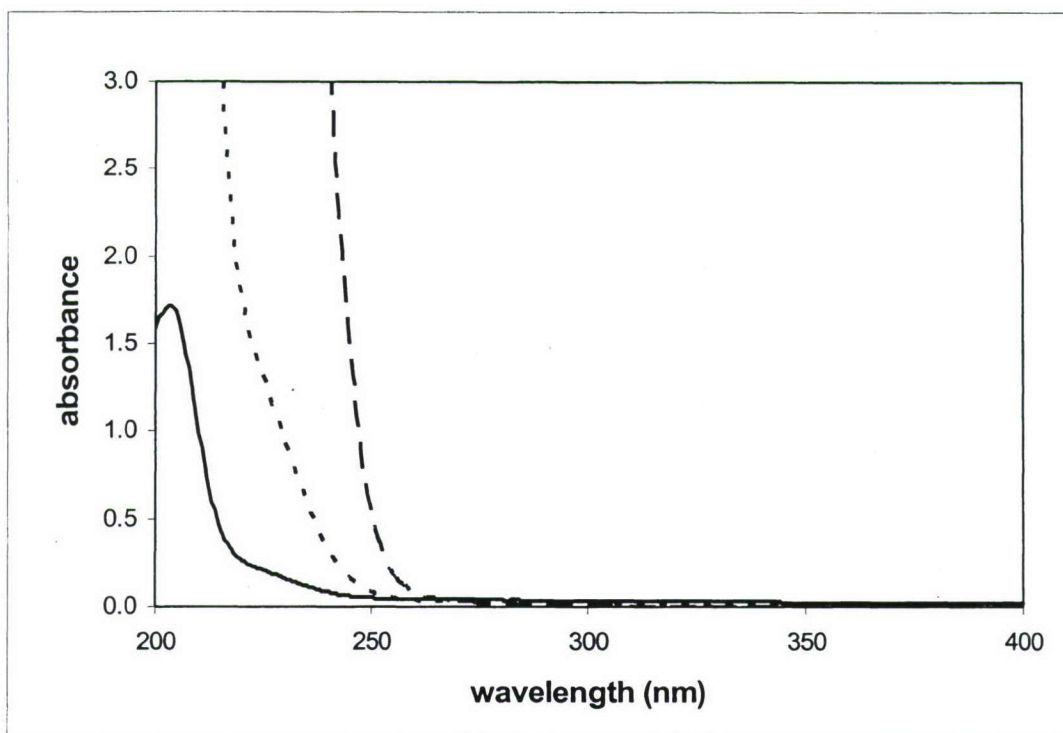


Figure B-27. Absorption Spectrum of  $9.74 \times 10^{-4}$  M (solid line),  $7.75 \times 10^{-3}$  M (dotted line), and  $4.28 \times 10^{-2}$  M (dashed line) HD

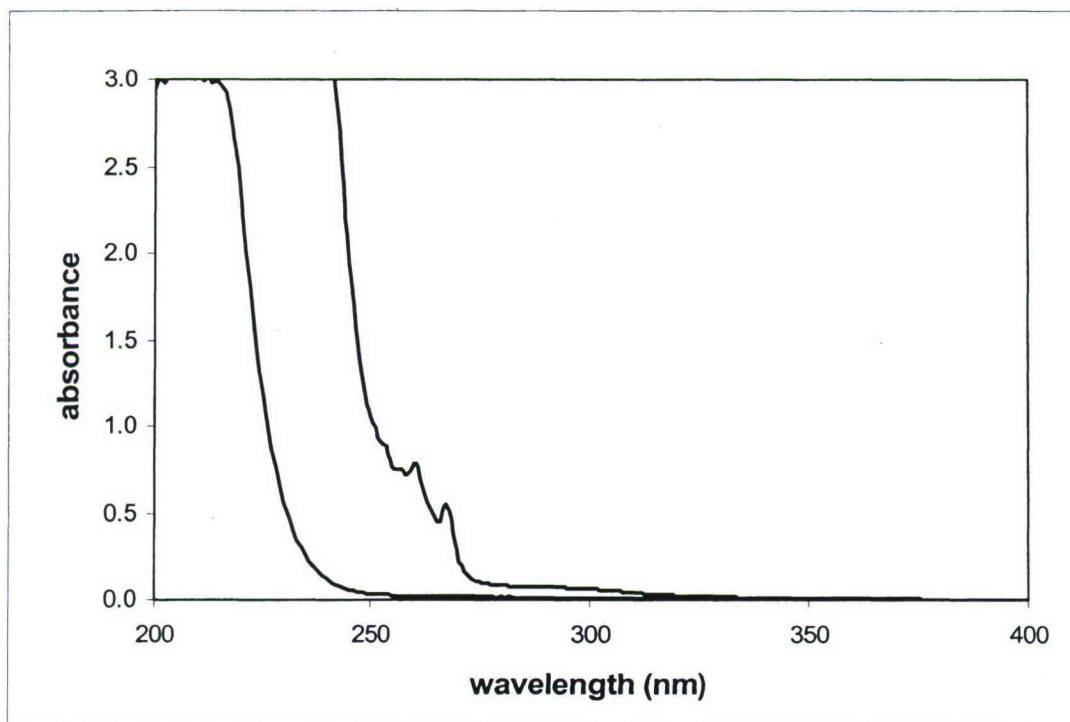


Figure B-28. Absorption Spectrum of  $6.64 \times 10^{-1}$  M (upper trace) and  $6.81 \times 10^{-3}$  M (lower trace) GA

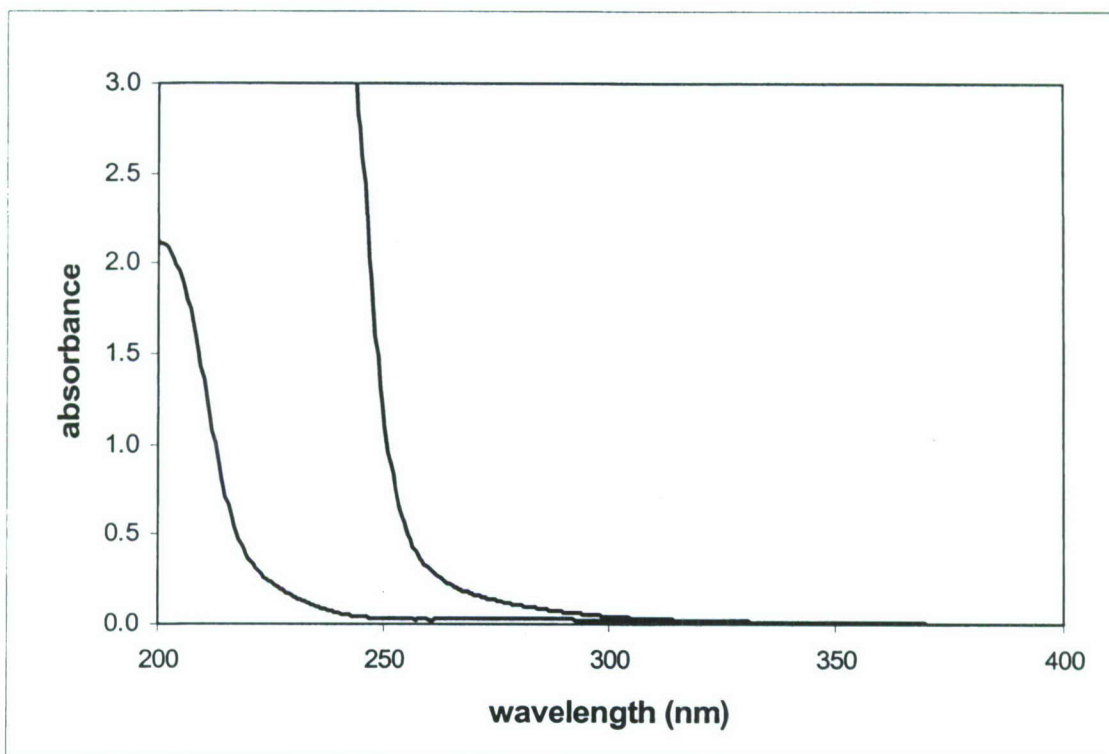


Figure B-29. Absorption Spectrum of  $3.22 \times 10^{-1} \text{ M}$  (upper trace) and  $9.98 \times 10^{-4} \text{ M}$  (lower trace) TDG

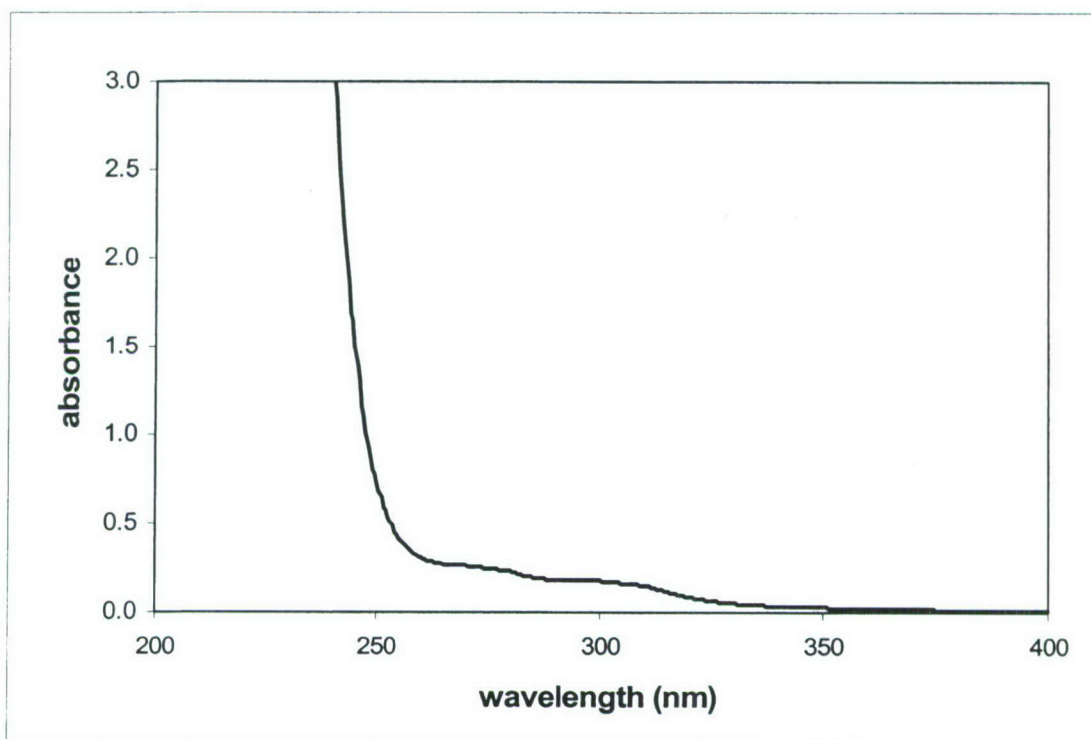


Figure B-30. Absorption Spectrum of  $4.67 \times 10^{-2} \text{ M T}$

Blank



## APPENDIX C

MOLAR ABSORPTIVITY DATA ( $\text{L mole}^{-1} \text{ cm}^{-1}$ )

Wavelength (nm)	CEES	BZ	AsCl <sub>3</sub>	CN	PS	GF
400	2.76E-03	1.99E+00	2.30E-03	2.50E+00	1.05E-02	1.04E+00
398	2.82E-03	2.02E+00	1.34E-02	2.30E+00	1.87E-02	1.06E+00
396	1.91E-03	2.09E+00	2.70E-02	2.65E+00	2.78E-02	1.08E+00
394	1.86E-04	2.10E+00	8.83E-02	3.51E+00	3.52E-02	1.09E+00
392	2.81E-03	2.14E+00	8.57E-02	9.92E-01	4.39E-02	1.11E+00
390	5.22E-04	2.08E+00	1.67E-01	1.28E+00	5.36E-02	1.13E+00
388	6.33E-03	2.12E+00	1.50E-01	2.05E+00	7.26E-02	1.15E+00
386	3.69E-03	2.12E+00	1.58E-01	1.14E+00	8.68E-02	1.17E+00
384	6.27E-03	2.15E+00	2.15E-01	2.02E+00	1.08E-01	1.19E+00
382	5.96E-03	2.15E+00	2.52E-01	1.35E+00	1.32E-01	1.21E+00
380	6.18E-03	2.17E+00	3.06E-01	1.54E+00	1.57E-01	1.23E+00
378	7.67E-03	2.25E+00	3.48E-01	7.90E-01	1.86E-01	1.26E+00
376	7.27E-03	2.27E+00	3.92E-01	1.15E+00	2.17E-01	1.28E+00
374	8.11E-03	2.30E+00	4.59E-01	3.90E-02	2.50E-01	1.30E+00
372	9.11E-03	2.29E+00	4.55E-01	7.70E-01	3.02E-01	1.33E+00
370	9.23E-03	2.32E+00	5.39E-01	1.44E+00	3.54E-01	1.36E+00
368	9.44E-03	2.34E+00	5.74E-01	2.58E+00	4.08E-01	1.39E+00
366	9.85E-03	2.36E+00	6.60E-01	2.96E+00	4.62E-01	1.42E+00
364	1.08E-02	2.42E+00	7.11E-01	3.28E+00	5.14E-01	1.44E+00
362	1.12E-02	2.45E+00	7.59E-01	3.47E+00	5.80E-01	1.47E+00
360	1.10E-02	2.51E+00	7.51E-01	3.41E+00	6.46E-01	1.50E+00
358	1.28E-02	2.58E+00	7.72E-01	5.41E+00	7.11E-01	1.53E+00
356	1.44E-02	2.59E+00	7.11E-01	2.80E+00	8.02E-01	1.57E+00
354	1.56E-02	2.57E+00	7.47E-01	4.24E+00	8.83E-01	1.60E+00
352	1.86E-02	2.64E+00	7.04E-01	4.78E+00	9.95E-01	1.64E+00
350	2.02E-02	2.68E+00	6.74E-01	5.52E+00	1.11E+00	1.68E+00
348	2.17E-02	2.75E+00	6.29E-01	7.96E+00	1.21E+00	1.73E+00
346	2.37E-02	2.77E+00	6.19E-01	1.28E+01	1.33E+00	1.78E+00
344	2.56E-02	2.84E+00	5.29E-01	1.63E+01	1.46E+00	1.83E+00
342	2.81E-02	2.89E+00	5.60E-01	1.90E+01	1.60E+00	1.89E+00
340	3.37E-02	2.93E+00	5.83E-01	2.48E+01	1.74E+00	1.96E+00
338	3.99E-02	2.95E+00	6.01E-01	2.92E+01	1.88E+00	2.02E+00
336	4.74E-02	3.00E+00	6.47E-01	3.38E+01	2.08E+00	2.09E+00
334	5.55E-02	3.04E+00	7.16E-01	3.93E+01	2.25E+00	2.17E+00
332	6.67E-02	3.11E+00	8.26E-01	4.36E+01	2.43E+00	2.24E+00
330	7.76E-02	3.20E+00	9.86E-01	4.78E+01	2.65E+00	2.32E+00
328	9.14E-02	3.24E+00	1.11E+00	5.13E+01	2.86E+00	2.39E+00
326	1.11E-01	3.29E+00	1.33E+00	5.50E+01	3.13E+00	2.48E+00
324	1.34E-01	3.34E+00	1.49E+00	5.82E+01	3.42E+00	2.56E+00
322	1.59E-01	3.40E+00	1.81E+00	5.78E+01	3.74E+00	2.65E+00
320	1.99E-01	3.42E+00	2.06E+00	6.35E+01	4.11E+00	2.71E+00
318	2.32E-01	3.51E+00	2.39E+00	6.49E+01	4.52E+00	2.78E+00
316	2.77E-01	3.57E+00	2.78E+00	6.84E+01	5.09E+00	2.85E+00
314	3.11E-01	3.64E+00	3.18E+00	6.99E+01	5.66E+00	2.90E+00
312	3.43E-01	3.69E+00	3.69E+00	7.19E+01	6.41E+00	2.96E+00
310	3.68E-01	3.77E+00	4.23E+00	7.45E+01	7.34E+00	3.01E+00
308	3.85E-01	3.84E+00	4.79E+00	7.74E+01	8.43E+00	3.06E+00
306	4.02E-01	3.91E+00	5.58E+00	8.40E+01	9.90E+00	3.10E+00
304	4.17E-01	3.98E+00	6.36E+00	9.58E+01	1.16E+01	3.14E+00

Wavelength (nm)	CEES	BZ	AsCl3	CN	PS	GF
302	4.38E-01	4.08E+00	7.36E+00	1.17E+02	1.40E+01	3.18E+00
300	4.57E-01	4.18E+00	8.40E+00	1.49E+02	1.64E+01	3.22E+00
298	4.73E-01	4.29E+00	9.60E+00	1.98E+02	1.88E+01	3.26E+00
296	4.89E-01	4.42E+00	1.10E+01	2.81E+02	2.22E+01	3.31E+00
294	4.89E-01	4.56E+00	1.27E+01	3.71E+02	2.54E+01	3.35E+00
292	5.13E-01	4.73E+00	1.45E+01	4.99E+02	2.94E+01	3.42E+00
290	5.31E-01	5.00E+00	1.69E+01	6.51E+02	2.97E+01	3.47E+00
288	5.57E-01	5.19E+00	1.90E+01	7.66E+02	2.97E+01	3.53E+00
286	5.93E-01	5.59E+00	2.17E+01	8.81E+02	2.97E+01	3.59E+00
284	6.26E-01	6.10E+00	2.43E+01	9.44E+02	2.97E+01	3.65E+00
282	6.70E-01	6.54E+00	2.77E+01	1.02E+03	2.97E+01	3.74E+00
280	7.16E-01	7.30E+00	3.12E+01	1.08E+03	2.97E+01	3.81E+00
278	7.73E-01	7.93E+00	3.46E+01	1.12E+03	2.97E+01	3.87E+00
276	8.55E-01	8.97E+00	3.91E+01	1.13E+03	2.97E+01	3.93E+00
274	9.64E-01	1.08E+01	4.35E+01	1.13E+03	2.97E+01	3.99E+00
272	1.09E+00	1.50E+01	4.99E+01	1.15E+03	2.97E+01	4.05E+00
270	1.16E+00	2.55E+01	5.55E+01	1.18E+03	2.97E+01	4.11E+00
268	1.33E+00	4.08E+01	6.19E+01	1.26E+03	2.97E+01	4.14E+00
266	1.57E+00	8.98E+01	7.00E+01	1.42E+03	2.97E+01	4.19E+00
264	1.82E+00	1.17E+02	7.74E+01	1.63E+03	2.97E+01	4.23E+00
262	2.22E+00	1.74E+02	8.85E+01	2.06E+03	2.97E+01	4.29E+00
260	2.72E+00	1.85E+02	9.98E+01	2.56E+03	2.97E+01	4.36E+00
258	3.41E+00	1.85E+02	1.11E+02	3.24E+03	2.97E+01	4.43E+00
256	4.62E+00	2.25E+02	1.28E+02	4.29E+03	2.97E+01	4.51E+00
254	5.98E+00	2.42E+02	1.44E+02	5.32E+03	2.97E+01	4.60E+00
252	8.66E+00	1.97E+02	1.71E+02	6.97E+03	2.69E+01	4.72E+00
250	1.18E+01	2.06E+02	1.94E+02	8.32E+03	2.39E+01	4.85E+00
248	1.71E+01	2.21E+02	2.33E+02	9.67E+03	2.18E+01	4.98E+00
246	2.39E+01	2.02E+02	2.76E+02	1.07E+04	1.97E+01	5.19E+00
244	3.02E+01	2.17E+02	3.19E+02	1.12E+04	1.88E+01	5.37E+00
242	3.49E+01	2.44E+02	4.08E+02	1.15E+04	1.94E+01	5.69E+00
240	3.49E+01	2.98E+02	4.92E+02	1.15E+04	2.25E+01	6.13E+00
238	3.49E+01	3.76E+02	6.00E+02	1.10E+04	2.83E+01	6.65E+00
236	3.49E+01	4.78E+02	7.43E+02	1.03E+04	2.97E+01	7.28E+00
234	3.49E+01	5.11E+02	7.59E+02	9.49E+03	2.97E+01	7.83E+00
232	3.49E+01	5.11E+02	7.59E+02	8.30E+03	2.97E+01	8.49E+00
230	3.49E+01	5.11E+02	7.59E+02	7.19E+03	2.97E+01	8.95E+00
228	3.49E+01	5.11E+02	7.59E+02	6.05E+03	2.97E+01	9.43E+00
226	3.49E+01	5.11E+02	7.59E+02	5.09E+03	2.97E+01	9.75E+00
224	3.49E+01	5.11E+02	7.59E+02	4.25E+03	2.97E+01	9.89E+00
222	3.49E+01	5.11E+02	7.59E+02	3.37E+03	2.97E+01	1.00E+01
220	3.49E+01	5.11E+02	7.59E+02	2.80E+03	2.97E+01	1.01E+01
218	3.49E+01	5.11E+02	7.59E+02	2.33E+03	2.97E+01	1.03E+01
216	3.49E+01	5.11E+02	7.59E+02	2.22E+03	2.97E+01	1.06E+01
214	3.49E+01	5.11E+02	7.59E+02	2.44E+03	2.97E+01	1.09E+01
212	3.49E+01	5.11E+02	7.59E+02	3.22E+03	2.97E+01	1.15E+01
210	3.49E+01	5.11E+02	7.59E+02	4.63E+03	2.97E+01	1.25E+01
208	3.49E+01	5.11E+02	7.59E+02	7.55E+03	2.97E+01	1.39E+01
206	3.49E+01	5.11E+02	7.59E+02	1.02E+04	2.97E+01	1.41E+01
204	3.49E+01	4.65E+02	7.59E+02	1.30E+04	2.97E+01	1.41E+01
202	3.49E+01	4.36E+02	7.59E+02	1.60E+04	2.97E+01	1.41E+01



Wavelength (nm)	CEES	BZ	AsCl3	CN	PS	GF
200	3.49E+01	4.10E+02	7.59E+02	1.74E+04	2.97E+01	1.41E+01

Wavelength (nm)	DEM	EMPA	ED	IMPA	L	MES
400	3.18E-04	5.83E-04	3.31E-01	1.70E-02	1.48E+00	5.34E+00
398	4.64E-04	6.39E-04	3.67E-01	1.73E-02	1.86E+00	5.22E+00
396	1.22E-04	6.85E-04	3.05E-01	1.77E-02	2.11E+00	5.38E+00
394	2.15E-04	7.38E-04	3.41E-01	1.80E-02	2.35E+00	5.23E+00
392	6.35E-04	7.94E-04	2.67E-01	1.85E-02	2.78E+00	5.24E+00
390	7.11E-06	9.00E-04	3.31E-01	1.88E-02	1.43E+00	5.23E+00
388	6.10E-04	9.14E-04	2.45E-01	1.94E-02	3.63E+00	5.28E+00
386	4.36E-04	9.52E-04	2.23E-01	1.98E-02	1.59E+00	5.56E+00
384	4.94E-04	1.03E-03	2.64E-01	2.03E-02	2.15E+00	5.42E+00
382	4.41E-04	1.11E-03	2.69E-01	2.08E-02	3.06E-01	5.48E+00
380	3.26E-04	1.19E-03	2.54E-01	2.12E-02	1.47E+00	5.49E+00
378	4.76E-04	1.27E-03	2.16E-01	2.17E-02	1.01E+00	5.73E+00
376	4.18E-04	1.36E-03	2.78E-01	2.21E-02	5.30E-01	5.41E+00
374	4.90E-04	1.45E-03	2.36E-01	2.26E-02	1.16E+00	5.28E+00
372	3.64E-04	1.52E-03	2.59E-01	2.31E-02	1.58E+00	5.52E+00
370	5.98E-04	1.65E-03	2.54E-01	2.36E-02	1.56E+00	5.56E+00
368	5.86E-04	1.75E-03	2.16E-01	2.41E-02	1.93E+00	5.66E+00
366	6.13E-04	1.89E-03	3.18E-01	2.46E-02	1.24E+00	5.49E+00
364	7.18E-04	2.01E-03	2.74E-01	2.51E-02	2.05E+00	5.45E+00
362	7.42E-04	2.15E-03	3.05E-01	2.55E-02	1.86E+00	5.69E+00
360	7.14E-04	2.29E-03	1.23E-01	2.59E-02	3.38E-01	5.41E+00
358	1.00E-03	2.44E-03	1.74E-01	2.62E-02	1.65E+00	5.37E+00
356	1.95E-04	2.63E-03	2.46E-01	2.66E-02	8.49E-01	5.07E+00
354	8.44E-04	2.80E-03	2.36E-01	2.70E-02	3.30E+00	5.68E+00
352	1.07E-03	3.00E-03	1.75E-01	2.74E-02	1.56E+00	5.77E+00
350	1.32E-03	3.24E-03	1.68E-01	2.79E-02	1.84E+00	6.19E+00
348	1.56E-03	3.44E-03	9.84E-02	2.83E-02	1.56E+00	6.84E+00
346	2.14E-03	3.72E-03	1.17E-01	2.88E-02	1.51E+00	8.48E+00
344	2.82E-03	3.96E-03	6.75E-02	2.93E-02	1.53E+00	1.06E+01
342	4.05E-03	4.27E-03	6.49E-02	2.99E-02	2.24E+00	1.50E+01
340	6.55E-03	4.59E-03	2.73E-04	3.05E-02	2.20E+00	2.24E+01
338	1.00E-02	4.88E-03	1.61E-01	3.12E-02	2.42E+00	3.38E+01
336	1.63E-02	5.22E-03	3.11E-02	3.20E-02	3.64E+00	5.69E+01
334	2.69E-02	5.59E-03	1.62E-01	3.27E-02	3.33E+00	9.10E+01
332	4.50E-02	5.91E-03	1.52E-01	3.35E-02	4.55E+00	1.54E+02
330	7.23E-02	6.33E-03	2.14E-01	3.46E-02	6.45E+00	2.61E+02
328	1.13E-01	6.73E-03	3.32E-01	3.55E-02	7.35E+00	3.97E+02
326	1.81E-01	7.22E-03	4.93E-01	3.67E-02	9.13E+00	6.41E+02
324	2.59E-01	7.72E-03	6.28E-01	3.76E-02	9.65E+00	9.26E+02
322	3.59E-01	8.24E-03	8.46E-01	3.85E-02	1.27E+01	1.26E+03
320	4.88E-01	8.72E-03	1.16E+00	3.96E-02	1.54E+01	1.67E+03
318	6.11E-01	9.26E-03	1.33E+00	4.04E-02	1.81E+01	2.07E+03
316	7.48E-01	9.96E-03	1.73E+00	4.17E-02	2.31E+01	2.53E+03
314	8.57E-01	1.06E-02	2.08E+00	4.26E-02	2.73E+01	2.91E+03
312	9.47E-01	1.15E-02	2.59E+00	4.37E-02	3.18E+01	3.21E+03
310	1.02E+00	1.25E-02	3.06E+00	4.47E-02	3.72E+01	3.45E+03
308	1.07E+00	1.35E-02	3.80E+00	4.58E-02	4.32E+01	3.62E+03
306	1.12E+00	1.50E-02	4.66E+00	4.70E-02	5.03E+01	3.71E+03

Wavelength (nm)	DEM	EMPA	ED	IMPA	L	MES
304	1.14E+00	1.66E-02	5.52E+00	4.82E-02	5.70E+01	3.78E+03
302	1.13E+00	1.89E-02	7.01E+00	4.97E-02	6.69E+01	3.75E+03
300	1.11E+00	2.11E-02	8.28E+00	5.13E-02	7.65E+01	3.66E+03
298	1.06E+00	2.32E-02	9.98E+00	5.28E-02	8.70E+01	3.53E+03
296	1.00E+00	2.53E-02	1.24E+01	5.45E-02	1.00E+02	3.29E+03
294	9.34E-01	2.71E-02	1.48E+01	5.61E-02	1.14E+02	3.06E+03
292	8.55E-01	2.86E-02	1.89E+01	5.86E-02	1.32E+02	2.77E+03
290	7.82E-01	3.06E-02	2.36E+01	6.09E-02	1.50E+02	2.49E+03
288	7.15E-01	3.21E-02	2.96E+01	6.37E-02	1.72E+02	2.23E+03
286	6.24E-01	3.36E-02	3.82E+01	6.67E-02	2.05E+02	1.92E+03
284	5.60E-01	3.50E-02	4.70E+01	6.93E-02	2.36E+02	1.69E+03
282	4.88E-01	3.65E-02	6.06E+01	7.21E-02	2.81E+02	1.42E+03
280	4.34E-01	3.78E-02	7.52E+01	7.47E-02	3.39E+02	1.21E+03
278	3.83E-01	3.87E-02	9.41E+01	7.73E-02	3.96E+02	1.02E+03
276	3.44E-01	3.96E-02	1.20E+02	8.03E-02	4.76E+02	8.35E+02
274	3.17E-01	4.06E-02	1.45E+02	8.33E-02	5.68E+02	6.88E+02
272	2.93E-01	4.18E-02	1.84E+02	8.84E-02	7.03E+02	5.45E+02
270	2.74E-01	4.28E-02	2.22E+02	9.24E-02	8.44E+02	4.41E+02
268	2.62E-01	4.42E-02	2.67E+02	9.83E-02	1.00E+03	3.48E+02
266	2.67E-01	4.62E-02	3.20E+02	1.08E-01	1.20E+03	2.74E+02
264	2.80E-01	4.85E-02	3.68E+02	1.21E-01	1.39E+03	2.23E+02
262	3.10E-01	5.24E-02	4.44E+02	1.41E-01	1.65E+03	1.84E+02
260	3.60E-01	5.68E-02	5.09E+02	1.53E-01	1.90E+03	1.68E+02
258	4.17E-01	6.18E-02	5.70E+02	1.62E-01	2.18E+03	1.73E+02
256	4.98E-01	6.78E-02	6.49E+02	1.76E-01	2.45E+03	2.09E+02
254	5.88E-01	7.43E-02	7.12E+02	1.83E-01	2.72E+03	2.82E+02
252	7.76E-01	8.55E-02	7.84E+02	1.87E-01	3.06E+03	4.70E+02
250	1.02E+00	9.63E-02	8.40E+02	1.89E-01	3.35E+03	7.90E+02
248	1.54E+00	1.16E-01	9.01E+02	1.91E-01	3.65E+03	1.41E+03
246	2.25E+00	1.39E-01	9.45E+02	1.90E-01	4.01E+03	2.45E+03
244	3.05E+00	1.64E-01	9.73E+02	1.89E-01	4.32E+03	3.30E+03
242	4.58E+00	2.10E-01	1.01E+03	1.89E-01	4.71E+03	3.89E+03
240	4.62E+00	2.45E-01	1.03E+03	1.89E-01	5.18E+03	3.89E+03
238	4.62E+00	2.95E-01	1.04E+03	1.93E-01	5.66E+03	3.89E+03
236	4.62E+00	3.47E-01	1.04E+03	1.99E-01	6.21E+03	3.89E+03
234	4.62E+00	3.86E-01	1.02E+03	2.05E-01	6.74E+03	3.89E+03
232	4.62E+00	4.24E-01	9.76E+02	2.15E-01	7.44E+03	3.89E+03
230	4.62E+00	4.57E-01	9.25E+02	2.27E-01	7.97E+03	3.89E+03
228	4.62E+00	4.76E-01	8.43E+02	2.43E-01	8.66E+03	3.89E+03
226	4.62E+00	4.76E-01	7.67E+02	2.62E-01	9.17E+03	3.89E+03
224	4.62E+00	4.76E-01	6.94E+02	2.81E-01	9.51E+03	3.89E+03
222	4.62E+00	4.76E-01	6.09E+02	3.14E-01	9.81E+03	3.89E+03
220	4.62E+00	4.76E-01	5.56E+02	3.45E-01	1.00E+04	3.84E+03
218	4.62E+00	4.76E-01	5.22E+02	3.78E-01	1.02E+04	3.76E+03
216	4.62E+00	4.76E-01	5.22E+02	3.78E-01	1.03E+04	3.89E+03
214	4.62E+00	4.76E-01	5.52E+02	3.78E-01	1.04E+04	3.89E+03
212	4.62E+00	4.76E-01	6.12E+02	3.78E-01	1.03E+04	3.89E+03
210	4.62E+00	4.76E-01	6.87E+02	3.78E-01	1.03E+04	3.89E+03
208	4.62E+00	4.76E-01	8.02E+02	3.78E-01	1.01E+04	3.89E+03
206	4.62E+00	4.76E-01	9.25E+02	3.78E-01	9.99E+03	3.89E+03
204	4.62E+00	4.76E-01	1.06E+03	3.78E-01	9.74E+03	3.89E+03



Wavelength (nm)	DEM	EMPA	ED	IMPA	L	MES
202	4.62E+00	4.76E-01	1.22E+03	3.78E-01	9.60E+03	3.89E+03
200	4.62E+00	4.76E-01	1.34E+03	3.78E-01	9.59E+03	3.89E+03

Wavelength (nm)	MD	MPA	HN-1	HN-3	DIMP	DMMP
400	5.40E-01	5.84E-03	4.35E-01	5.31E-01	5.88E-03	4.65E-04
398	6.28E-01	6.00E-03	4.57E-01	5.64E-01	6.06E-03	6.23E-04
396	5.80E-01	5.97E-03	4.74E-01	5.94E-01	6.23E-03	7.71E-04
394	6.16E-01	6.07E-03	4.92E-01	6.31E-01	6.30E-03	8.78E-04
392	5.17E-01	6.23E-03	5.09E-01	6.71E-01	6.56E-03	1.11E-03
390	9.94E-01	6.47E-03	5.29E-01	6.98E-01	6.48E-03	1.29E-03
388	6.33E-01	6.54E-03	5.59E-01	7.46E-01	6.63E-03	1.55E-03
386	4.87E-01	6.71E-03	5.83E-01	7.88E-01	6.88E-03	1.74E-03
384	6.40E-01	6.79E-03	6.17E-01	8.27E-01	6.89E-03	1.92E-03
382	6.17E-01	7.12E-03	6.54E-01	8.77E-01	7.17E-03	2.10E-03
380	5.79E-01	7.12E-03	6.90E-01	9.23E-01	7.33E-03	2.26E-03
378	6.20E-01	7.17E-03	7.33E-01	9.72E-01	7.45E-03	2.42E-03
376	5.02E-01	7.29E-03	7.73E-01	1.02E+00	7.75E-03	2.55E-03
374	6.18E-01	7.49E-03	8.18E-01	1.06E+00	7.84E-03	2.73E-03
372	3.85E-01	7.66E-03	8.86E-01	1.11E+00	8.11E-03	2.90E-03
370	6.42E-01	8.19E-03	9.48E-01	1.15E+00	8.61E-03	3.07E-03
368	5.61E-01	8.34E-03	1.01E+00	1.19E+00	8.75E-03	3.25E-03
366	6.23E-01	8.69E-03	1.07E+00	1.22E+00	9.02E-03	3.40E-03
364	7.84E-01	8.98E-03	1.13E+00	1.24E+00	9.28E-03	3.67E-03
362	6.89E-01	9.52E-03	1.20E+00	1.27E+00	9.41E-03	3.87E-03
360	6.72E-01	9.90E-03	1.27E+00	1.27E+00	9.91E-03	4.04E-03
358	6.15E-01	1.03E-02	1.33E+00	1.29E+00	1.02E-02	4.09E-03
356	4.14E-01	1.05E-02	1.42E+00	1.28E+00	1.05E-02	4.24E-03
354	5.49E-01	1.18E-02	1.49E+00	1.28E+00	1.06E-02	4.55E-03
352	4.21E-01	1.28E-02	1.57E+00	1.26E+00	1.10E-02	4.88E-03
350	4.41E-01	1.40E-02	1.64E+00	1.24E+00	1.12E-02	5.15E-03
348	3.29E-01	1.48E-02	1.72E+00	1.22E+00	1.17E-02	5.43E-03
346	2.70E-01	1.65E-02	1.81E+00	1.18E+00	1.20E-02	5.81E-03
344	1.23E-01	1.81E-02	1.89E+00	1.14E+00	1.25E-02	6.17E-03
342	1.87E-01	2.01E-02	1.99E+00	1.10E+00	1.30E-02	6.74E-03
340	1.94E-01	2.26E-02	2.11E+00	1.06E+00	1.32E-02	7.39E-03
338	1.44E-01	2.54E-02	2.22E+00	1.02E+00	1.37E-02	8.19E-03
336	8.26E-02	2.93E-02	2.39E+00	9.84E-01	1.43E-02	9.51E-03
334	1.08E-01	3.30E-02	2.55E+00	9.55E-01	1.49E-02	1.11E-02
332	1.30E-01	3.77E-02	2.75E+00	9.29E-01	1.56E-02	1.38E-02
330	1.45E-01	4.36E-02	2.97E+00	9.19E-01	1.63E-02	1.81E-02
328	2.70E-01	5.09E-02	3.20E+00	9.17E-01	1.71E-02	2.31E-02
326	2.95E-01	5.96E-02	3.48E+00	9.31E-01	1.81E-02	3.15E-02
324	3.47E-01	6.93E-02	3.76E+00	9.59E-01	1.92E-02	4.11E-02
322	6.34E-01	8.11E-02	4.04E+00	1.00E+00	2.06E-02	5.23E-02
320	6.88E-01	9.63E-02	4.32E+00	1.06E+00	2.20E-02	6.60E-02
318	8.60E-01	1.12E-01	4.57E+00	1.14E+00	2.35E-02	7.87E-02
316	1.16E+00	1.32E-01	4.83E+00	1.24E+00	2.59E-02	9.29E-02
314	1.36E+00	1.54E-01	5.04E+00	1.36E+00	2.82E-02	1.05E-01
312	1.69E+00	1.80E-01	5.23E+00	1.50E+00	3.06E-02	1.15E-01
310	2.11E+00	2.11E-01	5.39E+00	1.65E+00	3.35E-02	1.23E-01
308	2.59E+00	2.41E-01	5.52E+00	1.80E+00	3.64E-02	1.29E-01

Wavelength (nm)	MD	MPA	HN-1	HN-3	DIMP	DMMP
306	3.18E+00	2.81E-01	5.65E+00	1.99E+00	4.05E-02	1.34E-01
304	3.86E+00	3.22E-01	5.75E+00	2.17E+00	4.45E-02	1.36E-01
302	4.80E+00	3.72E-01	5.84E+00	2.38E+00	4.88E-02	1.37E-01
300	5.77E+00	4.27E-01	5.92E+00	2.59E+00	5.40E-02	1.35E-01
298	6.91E+00	4.82E-01	5.98E+00	2.77E+00	5.93E-02	1.31E-01
296	8.27E+00	5.52E-01	6.04E+00	2.97E+00	6.55E-02	1.26E-01
294	1.03E+01	6.19E-01	6.08E+00	3.14E+00	7.12E-02	1.20E-01
292	1.19E+01	6.92E-01	6.15E+00	3.27E+00	7.87E-02	1.15E-01
290	1.37E+01	7.70E-01	6.23E+00	3.37E+00	8.80E-02	1.10E-01
288	1.63E+01	8.42E-01	6.34E+00	3.45E+00	9.60E-02	1.09E-01
286	1.99E+01	9.38E-01	6.51E+00	3.49E+00	1.03E-01	1.03E-01
284	2.29E+01	1.01E+00	6.66E+00	3.50E+00	1.08E-01	9.77E-02
282	2.80E+01	1.10E+00	6.86E+00	3.49E+00	1.15E-01	9.08E-02
280	3.43E+01	1.17E+00	7.02E+00	3.45E+00	1.21E-01	8.56E-02
278	4.13E+01	1.24E+00	7.17E+00	3.41E+00	1.26E-01	8.33E-02
276	5.25E+01	1.31E+00	7.33E+00	3.38E+00	1.31E-01	8.15E-02
274	6.58E+01	1.37E+00	7.44E+00	3.38E+00	1.37E-01	7.76E-02
272	8.48E+01	1.43E+00	7.59E+00	3.41E+00	1.42E-01	7.33E-02
270	1.05E+02	1.48E+00	7.72E+00	3.51E+00	1.48E-01	7.05E-02
268	1.37E+02	1.52E+00	7.85E+00	3.66E+00	1.55E-01	7.26E-02
266	1.73E+02	1.55E+00	8.15E+00	3.95E+00	1.66E-01	7.27E-02
264	2.14E+02	1.57E+00	8.52E+00	4.28E+00	1.80E-01	7.07E-02
262	2.78E+02	1.59E+00	9.20E+00	4.82E+00	2.00E-01	7.12E-02
260	3.46E+02	1.61E+00	1.03E+01	5.54E+00	2.22E-01	7.15E-02
258	4.15E+02	1.62E+00	1.21E+01	6.61E+00	2.50E-01	7.14E-02
256	5.18E+02	1.62E+00	1.44E+01	7.95E+00	2.88E-01	7.42E-02
254	6.12E+02	1.62E+00	1.78E+01	9.80E+00	3.22E-01	7.83E-02
252	7.42E+02	1.62E+00	2.38E+01	1.33E+01	3.60E-01	8.65E-02
250	8.56E+02	1.62E+00	3.15E+01	1.78E+01	3.96E-01	9.93E-02
248	9.97E+02	1.61E+00	4.13E+01	2.45E+01	4.19E-01	1.28E-01
246	1.12E+03	1.60E+00	4.70E+01	3.56E+01	4.35E-01	1.69E-01
244	1.22E+03	1.59E+00	4.70E+01	4.69E+01	4.45E-01	2.13E-01
242	1.36E+03	1.58E+00	4.70E+01	5.02E+01	4.53E-01	2.70E-01
240	1.44E+03	1.58E+00	4.70E+01	5.02E+01	4.56E-01	3.03E-01
238	1.52E+03	1.58E+00	4.70E+01	5.02E+01	4.57E-01	3.21E-01
236	1.58E+03	1.57E+00	4.70E+01	5.02E+01	4.60E-01	3.25E-01
234	1.62E+03	1.57E+00	4.70E+01	5.02E+01	4.71E-01	3.25E-01
232	1.64E+03	1.57E+00	4.70E+01	5.02E+01	5.01E-01	3.25E-01
230	1.64E+03	1.58E+00	4.70E+01	5.02E+01	5.49E-01	3.25E-01
228	1.61E+03	1.60E+00	4.70E+01	5.02E+01	6.05E-01	3.25E-01
226	1.54E+03	1.62E+00	4.70E+01	5.02E+01	6.65E-01	3.25E-01
224	1.45E+03	1.65E+00	4.70E+01	5.02E+01	6.99E-01	3.25E-01
222	1.31E+03	1.70E+00	4.70E+01	5.02E+01	7.64E-01	3.25E-01
220	1.19E+03	1.75E+00	4.70E+01	5.02E+01	8.13E-01	3.25E-01
218	1.05E+03	1.82E+00	4.70E+01	5.02E+01	9.04E-01	3.25E-01
216	9.47E+02	1.88E+00	4.70E+01	5.02E+01	1.02E+00	3.25E-01
214	8.97E+02	1.96E+00	4.70E+01	5.02E+01	1.14E+00	3.25E-01
212	9.05E+02	2.05E+00	4.70E+01	5.02E+01	1.34E+00	3.25E-01
210	9.69E+02	2.15E+00	4.70E+01	5.02E+01	1.55E+00	3.25E-01
208	1.12E+03	2.25E+00	4.70E+01	5.02E+01	1.83E+00	3.25E-01
206	1.31E+03	2.36E+00	4.70E+01	5.02E+01	2.12E+00	3.25E-01



Wavelength (nm)	MD	MPA	HN-1	HN-3	DIMP	DMMP
204	1.52E+03	2.47E+00	4.70E+01	5.02E+01	2.31E+00	3.25E-01
202	1.73E+03	2.59E+00	4.70E+01	5.02E+01	2.52E+00	3.25E-01
200	1.89E+03	2.69E+00	4.70E+01	5.02E+01	2.61E+00	3.25E-01

Wavelength (nm)	VX	TEPO	PD	CX	PMPA	GB
400	1.78E+00	1.62E-02	4.56E+00	2.16E-05	1.76E-02	1.81E-01
398	1.96E+00	1.63E-02	4.55E+00	2.75E-04	1.82E-02	1.84E-01
396	2.11E+00	1.65E-02	4.56E+00	5.59E-04	1.87E-02	1.86E-01
394	2.28E+00	1.66E-02	4.42E+00	7.93E-04	1.94E-02	1.89E-01
392	2.35E+00	1.69E-02	4.33E+00	9.95E-04	1.99E-02	1.91E-01
390	2.25E+00	1.70E-02	5.29E+00	1.37E-03	2.09E-02	1.94E-01
388	2.47E+00	1.73E-02	4.59E+00	1.19E-03	2.15E-02	1.97E-01
386	2.51E+00	1.75E-02	4.51E+00	1.55E-03	2.20E-02	2.01E-01
384	2.55E+00	1.77E-02	4.52E+00	1.70E-03	2.30E-02	2.04E-01
382	2.62E+00	1.79E-02	4.63E+00	2.00E-03	2.41E-02	2.07E-01
380	2.81E+00	1.81E-02	4.51E+00	2.55E-03	2.49E-02	2.10E-01
378	2.86E+00	1.82E-02	4.51E+00	2.74E-03	2.61E-02	2.12E-01
376	2.82E+00	1.83E-02	4.49E+00	3.32E-03	2.71E-02	2.15E-01
374	3.01E+00	1.84E-02	4.58E+00	3.53E-03	2.82E-02	2.17E-01
372	3.26E+00	1.85E-02	4.42E+00	4.22E-03	2.95E-02	2.19E-01
370	3.33E+00	1.86E-02	4.56E+00	4.49E-03	3.08E-02	2.22E-01
368	3.53E+00	1.86E-02	4.50E+00	5.13E-03	3.22E-02	2.24E-01
366	3.59E+00	1.87E-02	4.78E+00	5.59E-03	3.37E-02	2.26E-01
364	3.77E+00	1.89E-02	4.78E+00	5.94E-03	3.51E-02	2.29E-01
362	3.88E+00	1.90E-02	4.46E+00	6.38E-03	3.68E-02	2.31E-01
360	3.95E+00	1.90E-02	4.71E+00	6.68E-03	3.83E-02	2.33E-01
358	4.36E+00	1.88E-02	4.65E+00	6.08E-03	4.01E-02	2.35E-01
356	4.46E+00	1.87E-02	4.28E+00	6.85E-03	4.15E-02	2.35E-01
354	5.25E+00	1.89E-02	4.55E+00	7.08E-03	4.38E-02	2.36E-01
352	5.20E+00	1.89E-02	4.60E+00	7.13E-03	4.63E-02	2.39E-01
350	5.48E+00	1.90E-02	4.64E+00	6.86E-03	4.85E-02	2.41E-01
348	5.71E+00	1.90E-02	4.65E+00	6.92E-03	5.07E-02	2.43E-01
346	6.09E+00	1.91E-02	4.45E+00	6.68E-03	5.37E-02	2.45E-01
344	6.44E+00	1.91E-02	4.20E+00	6.81E-03	5.63E-02	2.47E-01
342	6.97E+00	1.91E-02	4.24E+00	6.67E-03	5.95E-02	2.48E-01
340	7.42E+00	1.92E-02	4.42E+00	6.76E-03	6.32E-02	2.51E-01
338	7.87E+00	1.93E-02	4.36E+00	6.83E-03	6.67E-02	2.53E-01
336	8.36E+00	1.94E-02	4.31E+00	6.93E-03	7.09E-02	2.55E-01
334	8.98E+00	1.95E-02	4.38E+00	7.10E-03	7.54E-02	2.58E-01
332	9.45E+00	1.96E-02	4.56E+00	7.48E-03	8.06E-02	2.61E-01
330	1.02E+01	1.98E-02	4.67E+00	7.70E-03	8.63E-02	2.64E-01
328	1.08E+01	2.01E-02	4.67E+00	8.27E-03	9.25E-02	2.68E-01
326	1.16E+01	2.05E-02	4.86E+00	8.82E-03	1.01E-01	2.74E-01
324	1.22E+01	2.05E-02	4.60E+00	9.21E-03	1.08E-01	2.77E-01
322	1.26E+01	2.07E-02	5.47E+00	9.70E-03	1.17E-01	2.82E-01
320	1.37E+01	2.10E-02	5.77E+00	1.05E-02	1.28E-01	2.87E-01
318	1.43E+01	2.12E-02	6.30E+00	1.10E-02	1.38E-01	2.91E-01
316	1.53E+01	2.16E-02	7.08E+00	1.14E-02	1.48E-01	2.98E-01
314	1.60E+01	2.19E-02	8.01E+00	1.19E-02	1.57E-01	3.02E-01
312	1.69E+01	2.21E-02	9.36E+00	1.25E-02	1.64E-01	3.06E-01
310	1.79E+01	2.24E-02	1.09E+01	1.32E-02	1.71E-01	3.10E-01

Wavelength (nm)	VX	TEPO	PD	CX	PMPA	GB
308	1.86E+01	2.27E-02	1.26E+01	1.39E-02	1.77E-01	3.14E-01
306	1.98E+01	2.30E-02	1.50E+01	1.45E-02	1.86E-01	3.19E-01
304	2.08E+01	2.35E-02	1.79E+01	1.55E-02	1.96E-01	3.23E-01
302	2.20E+01	2.40E-02	2.17E+01	1.67E-02	2.10E-01	3.29E-01
300	2.34E+01	2.46E-02	2.61E+01	1.81E-02	2.26E-01	3.35E-01
298	2.49E+01	2.52E-02	3.14E+01	1.95E-02	2.40E-01	3.41E-01
296	2.68E+01	2.58E-02	3.88E+01	2.13E-02	2.57E-01	3.49E-01
294	2.87E+01	2.59E-02	4.86E+01	2.30E-02	2.74E-01	3.55E-01
292	3.13E+01	2.69E-02	6.10E+01	2.57E-02	3.01E-01	3.61E-01
290	3.43E+01	2.77E-02	8.03E+01	2.88E-02	3.42E-01	3.72E-01
288	3.69E+01	2.88E-02	9.98E+01	3.18E-02	3.96E-01	3.83E-01
286	4.11E+01	3.01E-02	1.34E+02	3.61E-02	4.88E-01	3.98E-01
284	4.55E+01	3.12E-02	1.76E+02	3.95E-02	5.77E-01	4.11E-01
282	5.20E+01	3.24E-02	2.44E+02	4.40E-02	6.79E-01	4.26E-01
280	5.89E+01	3.34E-02	3.34E+02	4.81E-02	7.36E-01	4.44E-01
278	6.58E+01	3.50E-02	4.31E+02	5.39E-02	7.62E-01	4.61E-01
276	7.72E+01	3.59E-02	5.69E+02	6.09E-02	7.85E-01	4.82E-01
274	8.79E+01	3.59E-02	6.79E+02	6.73E-02	8.07E-01	4.93E-01
272	1.04E+02	3.65E-02	8.16E+02	7.92E-02	8.16E-01	5.07E-01
270	1.23E+02	3.72E-02	9.29E+02	9.55E-02	8.04E-01	5.20E-01
268	1.42E+02	3.82E-02	1.06E+03	1.13E-01	7.86E-01	5.31E-01
266	1.71E+02	3.89E-02	1.20E+03	1.48E-01	7.71E-01	5.43E-01
264	2.01E+02	3.94E-02	1.30E+03	1.85E-01	7.63E-01	5.52E-01
262	2.42E+02	4.03E-02	1.46E+03	2.64E-01	7.59E-01	5.64E-01
260	2.89E+02	4.12E-02	1.59E+03	3.55E-01	7.69E-01	5.75E-01
258	3.47E+02	4.21E-02	1.72E+03	5.05E-01	7.90E-01	5.91E-01
256	4.06E+02	4.33E-02	1.88E+03	7.24E-01	8.31E-01	6.09E-01
254	4.77E+02	4.45E-02	2.02E+03	9.73E-01	8.84E-01	6.33E-01
252	5.71E+02	4.58E-02	2.19E+03	1.47E+00	9.81E-01	6.67E-01
250	6.69E+02	4.71E-02	2.34E+03	2.02E+00	1.07E+00	7.04E-01
248	7.80E+02	4.90E-02	2.53E+03	2.88E+00	1.24E+00	7.45E-01
246	9.16E+02	5.10E-02	2.73E+03	3.89E+00	1.42E+00	7.98E-01
244	1.03E+03	5.29E-02	2.90E+03	4.04E+00	1.58E+00	8.41E-01
242	1.19E+03	5.64E-02	3.20E+03	4.04E+00	1.90E+00	9.01E-01
240	1.35E+03	5.92E-02	3.38E+03	4.04E+00	2.10E+00	9.58E-01
238	1.50E+03	6.29E-02	3.60E+03	4.04E+00	2.10E+00	1.01E+00
236	1.63E+03	6.77E-02	3.79E+03	4.04E+00	2.10E+00	1.08E+00
234	1.77E+03	7.26E-02	3.93E+03	4.04E+00	2.10E+00	1.14E+00
232	1.77E+03	7.87E-02	4.03E+03	4.04E+00	2.10E+00	1.22E+00
230	1.77E+03	8.55E-02	4.02E+03	4.04E+00	2.10E+00	1.27E+00
228	1.77E+03	9.43E-02	4.07E+03	4.04E+00	2.10E+00	1.33E+00
226	1.77E+03	1.01E-01	3.91E+03	4.04E+00	2.10E+00	1.39E+00
224	1.77E+03	1.09E-01	3.77E+03	4.04E+00	2.10E+00	1.42E+00
222	1.77E+03	1.18E-01	3.59E+03	4.04E+00	2.10E+00	1.47E+00
220	1.77E+03	1.25E-01	3.47E+03	4.04E+00	2.10E+00	1.51E+00
218	1.77E+03	1.34E-01	3.40E+03	4.04E+00	2.10E+00	1.57E+00
216	1.77E+03	1.43E-01	3.47E+03	4.04E+00	2.10E+00	1.63E+00
214	1.77E+03	1.56E-01	3.61E+03	4.04E+00	2.10E+00	1.70E+00
212	1.77E+03	1.74E-01	3.91E+03	4.04E+00	2.10E+00	1.79E+00
210	1.77E+03	1.99E-01	4.07E+03	4.04E+00	2.10E+00	1.88E+00
208	1.77E+03	2.42E-01	4.07E+03	4.04E+00	2.10E+00	2.00E+00



Wavelength (nm)	VX	TEPO	PD	CX	PMPA	GB
206	1.77E+03	2.94E-01	4.07E+03	4.04E+00	2.10E+00	2.12E+00
204	1.77E+03	3.61E-01	4.07E+03	4.04E+00	2.10E+00	2.26E+00
202	1.77E+03	4.47E-01	4.07E+03	4.04E+00	2.10E+00	2.43E+00
200	1.77E+03	5.02E-01	4.07E+03	4.04E+00	2.10E+00	2.58E+00

Wavelength (nm)	GD	HD	GA	TDG	T
400	9.58E-03	4.26E-04	1.85E-03	5.71E-03	1.61E-01
398	1.02E-02	4.39E-03	2.37E-03	6.36E-03	1.74E-01
396	1.02E-02	7.31E-03	2.98E-03	6.66E-03	1.84E-01
394	9.88E-03	9.28E-03	3.51E-03	7.01E-03	1.96E-01
392	9.30E-03	1.39E-02	4.21E-03	7.98E-03	2.10E-01
390	9.90E-03	5.72E-03	4.20E-03	8.30E-03	2.09E-01
388	1.07E-02	1.62E-02	5.42E-03	9.27E-03	2.33E-01
386	1.01E-02	1.04E-02	5.36E-03	9.66E-03	2.40E-01
384	1.11E-02	9.06E-03	5.86E-03	1.07E-02	2.53E-01
382	1.16E-02	8.13E-03	6.25E-03	1.13E-02	2.66E-01
380	1.24E-02	1.29E-02	7.09E-03	1.20E-02	2.84E-01
378	1.26E-02	9.85E-03	7.57E-03	1.30E-02	3.07E-01
376	1.27E-02	8.93E-03	7.93E-03	1.37E-02	3.26E-01
374	1.38E-02	1.29E-02	8.21E-03	1.42E-02	3.49E-01
372	1.51E-02	2.35E-02	9.42E-03	1.54E-02	3.77E-01
370	1.68E-02	2.90E-02	9.84E-03	1.65E-02	3.96E-01
368	1.84E-02	4.14E-02	1.06E-02	1.74E-02	4.16E-01
366	1.89E-02	4.78E-02	1.07E-02	1.88E-02	4.31E-01
364	1.97E-02	4.25E-02	1.15E-02	1.99E-02	4.51E-01
362	2.07E-02	2.63E-02	1.18E-02	2.09E-02	4.67E-01
360	2.14E-02	2.10E-02	1.20E-02	2.21E-02	4.82E-01
358	2.22E-02	2.59E-02	1.31E-02	2.35E-02	5.01E-01
356	2.36E-02	2.17E-02	1.36E-02	2.38E-02	5.18E-01
354	2.60E-02	2.13E-02	1.45E-02	2.64E-02	5.45E-01
352	2.68E-02	1.88E-02	1.50E-02	2.81E-02	5.59E-01
350	2.84E-02	2.18E-02	1.60E-02	2.99E-02	5.83E-01
348	2.98E-02	1.96E-02	1.66E-02	3.13E-02	6.01E-01
346	3.18E-02	1.86E-02	1.76E-02	3.35E-02	6.31E-01
344	3.34E-02	1.45E-02	1.84E-02	3.56E-02	6.60E-01
342	3.62E-02	1.58E-02	1.92E-02	3.72E-02	6.96E-01
340	3.86E-02	1.42E-02	2.04E-02	3.95E-02	7.35E-01
338	4.01E-02	1.12E-02	2.14E-02	4.14E-02	7.78E-01
336	4.33E-02	1.32E-02	2.28E-02	4.40E-02	8.38E-01
334	4.57E-02	8.28E-03	2.40E-02	4.63E-02	8.95E-01
332	4.87E-02	1.15E-02	2.55E-02	4.91E-02	9.68E-01
330	5.17E-02	1.64E-02	2.77E-02	5.10E-02	1.06E+00
328	5.45E-02	2.02E-02	2.90E-02	5.42E-02	1.16E+00
326	5.88E-02	2.46E-02	3.11E-02	5.75E-02	1.29E+00
324	6.23E-02	2.84E-02	3.33E-02	6.13E-02	1.44E+00
322	6.68E-02	2.83E-02	3.62E-02	6.47E-02	1.63E+00
320	7.12E-02	4.76E-02	3.89E-02	6.91E-02	1.84E+00
318	7.52E-02	5.55E-02	4.29E-02	7.26E-02	2.07E+00
316	8.02E-02	7.20E-02	4.76E-02	7.88E-02	2.39E+00
314	8.47E-02	7.99E-02	5.20E-02	8.33E-02	2.69E+00
312	9.01E-02	9.07E-02	5.79E-02	8.99E-02	2.97E+00

Wavelength (nm)	GD	HD	GA	TDG	T
310	9.58E-02	1.00E-01	6.43E-02	9.66E-02	3.21E+00
308	1.01E-01	1.12E-01	6.99E-02	1.03E-01	3.37E+00
306	1.08E-01	1.24E-01	7.79E-02	1.12E-01	3.50E+00
304	1.14E-01	1.34E-01	8.35E-02	1.20E-01	3.59E+00
302	1.23E-01	1.53E-01	9.04E-02	1.31E-01	3.68E+00
300	1.31E-01	1.70E-01	9.53E-02	1.42E-01	3.78E+00
298	1.40E-01	1.90E-01	9.97E-02	1.52E-01	3.86E+00
296	1.50E-01	2.02E-01	1.04E-01	1.66E-01	3.94E+00
294	1.61E-01	2.21E-01	1.07E-01	1.80E-01	3.97E+00
292	1.74E-01	2.39E-01	1.09E-01	1.95E-01	3.97E+00
290	1.90E-01	2.55E-01	1.11E-01	2.11E-01	3.97E+00
288	2.05E-01	2.82E-01	1.13E-01	2.31E-01	4.00E+00
286	2.28E-01	3.27E-01	1.16E-01	2.57E-01	4.12E+00
284	2.51E-01	3.76E-01	1.19E-01	2.75E-01	4.32E+00
282	2.82E-01	4.20E-01	1.21E-01	3.01E-01	4.62E+00
280	3.18E-01	4.61E-01	1.27E-01	3.24E-01	4.95E+00
278	3.53E-01	5.16E-01	1.32E-01	3.52E-01	5.10E+00
276	4.03E-01	5.80E-01	1.44E-01	3.89E-01	5.23E+00
274	4.48E-01	6.36E-01	1.65E-01	4.21E-01	5.35E+00
272	5.04E-01	7.12E-01	2.31E-01	4.68E-01	5.51E+00
270	5.60E-01	8.01E-01	4.18E-01	5.05E-01	5.61E+00
268	6.07E-01	9.11E-01	7.66E-01	5.61E-01	5.67E+00
266	6.71E-01	1.05E+00	6.84E-01	6.30E-01	5.74E+00
264	7.29E-01	1.25E+00	7.74E-01	7.06E-01	5.88E+00
262	8.05E-01	1.61E+00	9.54E-01	8.19E-01	6.16E+00
260	8.87E-01	2.05E+00	1.19E+00	9.58E-01	6.59E+00
258	9.93E-01	2.81E+00	1.09E+00	1.13E+00	7.30E+00
256	1.12E+00	3.94E+00	1.14E+00	1.44E+00	8.31E+00
254	1.26E+00	5.51E+00	1.25E+00	1.85E+00	9.68E+00
252	1.45E+00	8.50E+00	1.38E+00	2.59E+00	1.22E+01
250	1.66E+00	1.25E+01	1.59E+00	3.39E+00	1.55E+01
248	1.90E+00	1.90E+01	1.90E+00	5.00E+00	2.00E+01
246	2.20E+00	2.87E+01	2.57E+00	7.05E+00	2.81E+01
244	2.48E+00	3.97E+01	3.30E+00	8.80E+00	3.62E+01
242	2.85E+00	5.70E+01	4.33E+00	9.32E+00	5.00E+01
240	3.30E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
238	3.74E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
236	4.29E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
234	4.81E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
232	5.57E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
230	5.88E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
228	5.88E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
226	5.88E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
224	5.88E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
222	5.88E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
220	5.88E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
218	5.88E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
216	5.88E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
214	5.88E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
212	5.88E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
210	5.88E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01

Wavelength (nm)	GD	HD	GA	TDG	T
208	5.88E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
206	5.88E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
204	5.88E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
202	5.88E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01
200	5.88E+00	7.02E+01	4.52E+00	9.32E+00	6.43E+01